The Role of Intellectual Property Rights in Biotechnology Transfer under the Convention on Biological Diversity

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Chakrabarty

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[54] MICROORGANISMS HAVING MULTIPLE COMPATIBLE DEGRADATIVE ENERGY-GENERATING PLASMIDS AND PREPARATION THEREOF

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Journal of Bacteriology vol. 106 pp. 468-478 (1971).
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[57] **ABSTRACT**

Unique microorganisms have been developed by the application of genetic engineering techniques. These microorganisms contain at least two stable (compatible) energy-generating plasmids, these plasmids specifying separate degradative pathways. The techniques for preparing such muti-plasmid strains from bacteria of the genus *Pseudomonas* are described. Living culture of the two strains of Pseudomonas (*P. aeruginosa* [HRRL B-5472] and *P. putida* [NRRL B-5473]) have been deposited with the United States Department of Agriculture, Agricultural Research Service, Northern Marketing and Nutrient Research Division, Peoria, Ill. The *P. aeruginosa* NRRL B-5472 was derived from *Pseudomonas aeruginosa* strain 1c by the genetic transfer thereto, and containment therein, of camphor, octane, salicylate and naphthalene degredative pathways in the form of plasmids. The *P. putida* NRLL B-5473 was derived from *Pseudomonas putida* strain PpGI by genetic transfer thereto, and containment therein, of camphor, salicylate and naphthalene degradative pathways and drug resistance factor RP-1, all in the form of plasmids.

18 Claims, 2 Drawing Figures

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Cover Picture: Beginning section the first patent application of a microorganism, issued in the USA, to A. M. Chakrabarty on 31 March 1981.

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Contents

Summary

This paper presents and discusses available information to assess the effects of intellectual property rights (IPRs) on technology transfer, particularly biotechnology. Technology transfer is the only specifically identified mechanism for achieving the objectives of the Convention on Biological Diversity, which are the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the use of biodiversity. Technology transfer is also presented as a means for achieving the rights of traditional and indigenous peoples. Effective technology transfer must be construed broadly to include bundles of technology with associated management practices and human capacity building in development, assessment, use, and related safeguards. These points emphasize that technology transfer must not only be efficacious in achieving the goals of the Convention, but it must also satisfy broad equity and ethical goals.

Technology is the application of knowledge to solving specific problems or meeting identified needs. Technology transfer is the application of technologies in new geographic or product areas, generally involving adaptation to local needs and conditions. Under the Convention, relevant technologies are identified as one means of achieving the objectives of conservation and sustainable use. Technology transfer is the means of providing broad access in an interdependent world. Noting that many relevant technologies are likely to be protected by intellectual property rights, such that the recognition of those rights becomes an aspect of technology transfer can draw specific connection to the objectives of the Convention. It is for this reason IPRs receive special consideration in this paper.

Biotechnology requires some further attention, if only because of its specific references within the Convention. Biotechnology, defined therein as "any technological application," applies to products, not procedures. Due to the diversity of product traits, biotechnology cannot be treated as a single entity, but rather must be addressed as a composite of products with individual specific attributes and transfer processes.

There are two conceptual justifications for IPRs: the personal property argument and incentive mechanism. Modern IPR systems typically emphasize the incentive factor. By emphasizing transfer, the Convention implicitly focuses on existing technologies, so that the access role of IPRs becomes more relevant.

Four forms of "traditional" IPR legislation are applicable for protecting the kinds of technologies, including biotechnologies, implied in Articles 16 and 18 of the Convention. These four, which can be used separately or jointly, include patents, Plant Breeders' Rights (PBR), trademarks, and trade secrets. Each is intended for a particular function and as such has specific attributes and exacting requirements. Certainly it is not possible to protect any form of innovation.

IPRs are intended primarily to foster private R&D. The available evidence generally supports that expectation; IPRs do indeed encourage investment by the private sector, especially for easily copied inventions. The evidence, however, is fragmentary and will not convince all readers, because IPR is but one means of protecting inventions. In many instances maintaining physical control, or secrecy, can be used as well. Nevertheless, according to the available evidence, IPR is an important component of an incentive system.

A secondary function of IPR is to encourage access to inventions produced elsewhere. This aspect is particularly significant to the Convention because of its emphasis on access and transfer. In general there is less evidence regarding the IPR implications for access than there is on the R&D incentive. This is especially true because it is almost impossible to prevent many inventions from moving internationally; seeds being a case in point. Nonetheless the evidence, while limited, does indicate that appropriate IPR does facilitate access, which was a principal motivation for its adoption in several countries. IPR systems have costs—royalty payments being the most obvious—but the costs of the absence of protection in terms of denied or delayed access must be determined on a case-by-case basis.

While there is no international tabulation of trade secret legislation, patent laws exist in over 100 countries; PBR laws in approximately 30 countries. The raw figures, however, do not give a complete indication of the status of protection. Close to 50 countries specifically exclude plants and animals from patent protection, although some patenting has been made possible by a narrow interpretation of the exclusion. On the other hand, the

number of countries with PBR legislation, especially members of UPOV, the international convention, has been growing rapidly, with several countries including Columbia, the Philippines and India, among others, expected to join in the near future. This is due at least in part to the Trade-Related Aspects of Intellectual Property Rights (TRIPs) agreement under GATT which specifies that certain minimal levels of protection be adopted within five to ten years.

Those who complain of a double standard regarding the IPR protection of genetic materials have a legitimate position. Conceptually, IPR protection for cooperative technologies—those produced by communities in accordance with age-old practices in the areas of genetic resources and landraces—fits smoothly within the historical development of IPR legislation. Practically speaking, however, current legislation is applicable to improved plant varieties but is not suited to landraces and the like, even though they are technically protectable. The closest that a current law comes to effective protection is the 1991 UPOV text. However, to be useful, a different interpretation (possibly involving a textual change) of the attributes of a derived variety would be required. That option should be considered, but it could be a difficult and lengthy process. Patents are usable for other materials, but the costs of documenting and preparing an application make patents a prohibitive approach for the great bulk of materials of uncertain use and value.

When the assessment is enlarged to include "non-traditional" forms of IPR, Farmers' Rights and folklore, they are not fully developed in their present forms for the protection of cooperative technologies. Appellations of origin have promise in some product areas, such as cosmetics, but would take creative adaptation, and would be limited at minimum. The FAO Code of Conduct is less a form of IPR and more a model contract.

Clearly, if IPR is not widely applicable to cooperative inventions, then it is ineffectual in aiding either the creation/preservation of cooperative technologies or the transfer of those technologies. In the past, access to those technologies has been good under the models of free access and the "common heritage of mankind". That era is evolving to a period of less access, or at least access on different terms.

Equity is a far-reaching concept involving individual, cultural, religious, and national matters such that international agreement is nearly impossible to achieve. Changes can be determined in a systematic way only by comparing "states" of social welfare, but that requires value judgments. Equity systems, referred to as "ability to pay" and "fair share," are based on such value judgments. One key value judgment is that money is "worth" more to the poor than to the rich. As intuitively appealing as this position may be, it lacks any substantive support, and becomes yet more complicated as events and time periods grow larger and longer.

For practical purposes, a simpler concept of equity is proposed. With this concept, known as marginality, it can be demonstrated using economic theory, that a form of equity results from a competitive market system with free trade. While remaining an idealized condition overall, marginality provides a state for which governments may strive. For technology transfer under the Convention, the marginality approach emphasizes, among other things, the importance of capacity building and training for developing country negotiators with multinational corporations. Capacity building cannot ensure balanced competition between those disparate parties, but competition certainly will not exist without skilled negotiators.

At a more fundamental level, the marginalist approach assumes that income distributions (as between developed and developing countries) do not matter for equity. Strictly speaking, this means that there is nothing inequitable in the fact that the richest nations have average per capita incomes over 50 times that of the poorest countries. Clearly that is a major limitation for seeking a position of true equity. But while limited, the marginalist approach does, at a minimum, provide a value-free approach to enhance equity in small, individual transactions which will have only limited effects on income distributions. It is recommended as a basis for technology transfer decisions until a broader consensus on equity emerges.

1. Introduction and Objectives

The issue of Intellectual Property Rights (IPRs) under the Convention on Biological Diversity (hereafter the Convention) received early and unfavorable attention when, at the Rio Summit in 1992, then-U.S. President Bush used inadequate protection for IPR as a justification for not signing the agreement. The USA has subsequently signed (but not ratified), and a respected industry representative has written that from an industry perspective there is no problem with IPR protection under the Convention (Duesing, 1992). Indeed, IPRs are mentioned in three of the five sections of Article 16 of the Convention, entitled Access to and Transfer of Technology. Subsequently, confusion with the interpretation of those sections as well as hostility to IPRs has reigned. In 1995, the Parties to the Convention established the operalization of Article 16 as part of the medium-term program of work (Items 5.4.1 and 5.5.1).

Much of the international debate has focused on the incentive role of IPRs, arguing that the poorest of the developing countries are not in a position to develop world class products, as required by patent law. The situation in many developing countries, where 98 percent of patents are granted to foreigners, is cited as evidence that patents do little more than provide import monopolies for multinationals. In this way, "equitable sharing" of benefits (Article 15.7) particularly for the use of indigenous knowledge (Article 8(j)), has become intertwined with the IPR debate. What has been lacking is a genuine discussion of the other major role of IPRs—that of facilitating access to new products and technologies.

The Convention established both a conservation and use mandate for genetic resources. The use aspects are the focus of Articles 15 and 16 for genetic resources and 16 for technologies, including biotechnologies. To some degree, products of biotechnology are based on genetic resources; about one third of prescription medicines are based on or have been identified from natural products. But more broadly, the Articles appear to describe a basis for mutual exchange, with developing countries supplying genetic resources and developed countries supplying technologies. Where this concept has run afoul is in the assumption by some of a barter (non-monetary) exchange of genetic resources and technologies. Governments of developed countries promptly noted that much of the sought-after technology was privately held and subject to IPRs; any exchange arrangements would have to be negotiated directly with the owners. The Convention itself states the preeminence of IPRs (Article 16.2), "... terms which recognize and are consistent with the adequate and effective protection of intellectual property rights."

So, under the Convention, interested parties must enter direct negotiations for access to technology, just as they did previously. What role, then, does the Convention play in technology transfer, particularly biotechnology transfer, and how is that related to IPR? This paper is directed to these topics.

2. Achieving Convention Objectives through Technology Transfer

The purpose of this section is to identify the connections among the Convention's objectives and technology transfer, IPR, and fair and equitable sharing of benefits derived from the use of genetic resources. It concludes with a more detailed assessment of the roles of IPR, emphasizing specific functions in fostering biotechnology transfer.

2.1 Convention Objectives

The objectives of the Convention, as described in Article 1, are as follows:

"…the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by **appropriate transfer of relevant technologies**…" (emphasis added).

While the sentence structure leaves this statement open to several interpretations, the general sense suggests that access to genetic resources and technology transfer is one mechanism for achieving the goals of conservation and sustainable use. Moreover, because transfer is the only mechanism specifically identified, it may be inferred that technology transfer is to be accorded special significance. The Convention does not attempt to define "technology transfer" and "technology" is characterized only as it "includes biotechnology" (Article 2).

2.2 Concepts of Technology and Technology Transfer

Anderson (1989) defines technology transfer as having occurred "when a country acquires, imitates, or adopts technology developed elsewhere." The term technology itself has been referred to as applied knowledge with a problem-solving intent. UNCTAD (1990) employs a related definition, the "transfer of systematic knowledge for the manufacture of a product, for the application of a process or for the rendering of a service." Because problems occur in a particular physical, economic and social environment, technologies must frequently be adapted locally to function across broad areas. Hence, DeGregori (1985) refers to technologies as being "both universal and particular."

Other definitional approaches distinguish between so called "soft" and "hard" technologies. Hard technologies incorporate the common concept of a machine, the embodiment of knowledge in a tangible form; while soft technologies are know-how, skills, and techniques, the unembodied form (Glowka, *et al.*, 1994, p. 85). From an economist's perspective, technologies allowing the same level of production at lower levels of input enhance efficiency (Peterson and Hayami, 1977). When the technological change uses the same proportion of land, labor, and capital inputs, it is referred to as neutral. New technologies which change the so-called factor shares to, for example, proportionally more capital than labor would be called biased technological change. When efficiency enhancements can be traced to capital, land or labor, they are known as embodied. However, a shift with no clear causal factor is described as disembodied change. Such shifts can be attributed to enhancements in management or knowledge in general—themselves a form of technology.

Another perspective is between "institutional" and "cooperative" innovation systems. The institutional innovation system refers to the scientific approach of specific and distinct objectives with a systematic path to a product; the whole often based on an individual's profit motive. Cooperative innovation is a more tradition-based system with diverse effort and benefit objectives shared on a communal basis (UNDP, 1994). In short, one applies to "modern" methods, while the other was and is associated with traditional peoples. The cooperative approach, because of its more diffuse objectives, among other differences, would be expected to lead to fewer large, seemingly discrete changes. These discrete changes are commonly referred to as inventions to distinguish them from the slow evolutionary process of technological change.

These approaches to the concepts of technology, technological change, and technology transfer reinforce the notion that this is both a complex and fundamental process. However, the distinctions of usage should not obscure the fact that the basic concept of technology is similar across groups. Technology is adapted, applied knowledge, whatever the source and means of generating that knowledge. At this level there is no real distinction between traditional and scientific knowledge. Technology transfer is simply the movement of technologies to additional applications; transfer may be geographic (the general concept) but could also refer to a different product application in the same location. The distinction becomes important in the ramifications of technology and technology transfer. Labor saving technologies, for example, are of social significance in areas of unemployment or low wages, but conceptually they are all technologies. Similarly, hard and soft technologies are conceptually the same, but the transfer process and the mechanisms to protect a soft innovation are often more limited, which leads to various controls over use, such as secrecy and patents.

These distinctions should be kept in mind when considering the existing and necessary mechanisms for achieving the Convention's technology transfer objectives. The objectives, for illustrative purposes, can be classified as first, second, and third line effects. The first line could be the activity of technology transfer itself; the second line could be its indirect effects, such as implications for labor requirements, and the third line could be the equity considerations for the providers/innovators.

2.3 Relationships of Convention Objectives to Technology and Technology Transfer

The Convention appears to take a pragmatic approach to technology; technology is a (one) possible means of achieving stated objectives. Those objectives include conservation and the sustainable use of genetic resources. No distinction is made, for example, between technology which can contribute to conservation directly by providing an alternative source for a material once harvested from the wild, or indirectly by enhancing the efficiency of agriculture and reducing the need for additional land.

Where the distinction is drawn is in regard to sources of technology, as it is implied that no country is self-sufficient in relevant technologies. Article 16.1 makes reference to facilitating "…access for and transfer to other Contracting Parties of technology…" Developing countries are identified as potential recipients of technologies:

"transfer of technology ... for the benefit of both governmental institutions and the private sector of developing countries…" (Article 16.4). These clauses recognize the current reality that technology is an international market and developing countries as a group are net importers of technology.

Within this Convention framework, technology is a means to achieve objectives, and technology transfer is a means to provide technologies where needed. It should be emphasized again that technology is but one method for achieving objectives—possibly the preferred one—but it is certainly not the only one. Much of the technology is in the public domain, yet much is also held by private institutions. Indeed, the bulk (up to three-quarters) of agricultural biotechnology research is estimated to be undertaken by the private sector, a departure from the previous round of publicly funded agricultural research (Persley, 1990). This means that access is feasible only if the requirements of the private owners are satisfied. Since many of those technologies are patented or protected by other forms of IPRs, they too must be respected. "In the case of technology subject to patents and other intellectual property rights, such access and transfer shall be provided on terms which recognize and are consistent with the adequate and effective protection of intellectual property rights." (Article 16.2). Through this causal chain, IPRs become a key component of technology transfer and a focus of this document.

The recognition of IPRs respects only one group of rights in technology transfer, those of the owners of protected technology. There are other players as well, including technology buyers and suppliers of (predominately) non-protected, nontraditional technologies such as genetic resources and the knowledge surrounding those resources. It is in this regard that the Convention terminology of "sharing in a fair and equitable way" (Article 15.7) can be understood. This paper considers technology transfer as two interrelated components: a) effective technology transfer as fostered by those IPRs, and b) equitable technology transfer for other classes of technology, particularly that of local and indigenous peoples.

Within this conceptual framework, biotechnology is not distinct from other forms of (largely protected) technology and warrants no special attention. However, because it is the only form of technology identified specifically in the Convention (see above), some additional comment is warranted. Biotechnology is distinct in several ways. First, the term is a shorthand means of saying "biotechnological application" (Article 2) as, strictly speaking, biotechnology is a methodology, not a class of products. This distinction is important because the biotechnology process can lead to many and diverse products. As delineated by the Open-Ended Intergovernmental Meeting of Experts, relevant products could be in the areas of environmental remediation, agriculture, industrial processes, and pharmaceuticals, among others (UNEP/CBD/IC/2/ll, 1994; see also Ollinger and Pope, 1995; Yuthavong and Gibbons, 1994). Furthermore, these products potentially can protect biodiversity, directly through remediation and indirectly by enhancing agricultural efficiency, while creating a market for genetic resources, as in pharmaceuticals and agriculture. Finally, at this early stage of the application of biotechnology products, it is not always clear what the practical promise of this wide range of possibilities will prove to be. Because of these diverse yet uncertain roles, biotechnology receives special attention within the Convention. It is important to realize that by singling out biotechnology, reference is made to a set of quite distinct potential products, many of which will have to be treated very differently in the transfer process. There is no single "biotechnology."

2.4 The Role of IPRs in Technology Transfer

There are two fundamental justifications for the IPR system. They are known as the personal property or "natural law" and economic incentive approaches. The personal property approach is based on Locke's concept of a right to property conferred by God upon all men in common (see Thompson, 1992, also Hughes, 1988). This is in contrast to the "absolute" power of sovereigns. That concept, however, applies to common property. But what about personal property? Locke handles that matter by introducing the idea of labor, "he that mixed his or her labor with and joined it to something that is his own, and thereby makes it his property." Underlying this concept is a view that a free person controls his labor, and a loss of the right to the product of that labor implies a loss of freedom. Property rights, including IPRs, are thus a means of protecting freedom.

The economic incentive approach is more pragmatic and less philosophical (the classical explanation is discussed by Machlup, 1958). It recognizes that the inventor assumes time and other costs associated with the creation process such that she/he could never compete on equal terms with copiers whose costs, minus the creation process, are lower. Hence the creator will always be undersold and has no incentive to invest. IPR legislation redresses the balance, at least in part, by prohibiting direct copying so long as the protection is in effect.

To be more specific, the invention process has been divided into three components: discovery, development, and commercialization. The discovery process itself seems to function more by the creative drive, or mere luck, and is somewhat removed from financial incentives. Development and commercialization, however, are the lengthy and costly processes of turning an idea, an insight, into a marketable product. Work at these stages is very responsive to incentives and can be considered as the real target of IPR systems (Jewkes *et al.,* 1969, Chaps. 15 and 16).

Of these competing concepts, which one is operable for current western systems? An insight can be gained from the authorizing legislation in the USA where the Constitution states "The Congress shall have the power ...To promote the progress of science and the useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." (Article 1, Sec. 8, emphasis added) This terminology has quite conclusively been identified as fostering economic incentives (Anderfelt, 1971).

A key function, if not the key function, of IPRs is therefore to provide incentives for investment in the creative process and in particular the transformation of basic insights into marketable products. These incentives are most applicable to private entities but have been used increasingly by the public sector as a source for generating research funding.

When considering the incentive effects, it is important to recognize what privileges IPRs do and do not provide. They do not assure a return; in fact only up to 15 percent of patents are ever commercialized (Nogues, 1989). They do not necessarily permit the use/practice of the creation. That is often controlled by regulation, e.g. biosafety in the case of biotechnology or even other patents. The only thing that IPRs allow is the right to exclude others from use of the invention. This can also be called negative rights. All financial rewards come from market sales. Hence key factors such as the breadth (scope) of protection and enforcement are critical in determining the practical value of IPR.

The Convention, however, is written as if pertinent technologies already exist, and the relevant matter is really access to those technologies. That implicit position begs the matter to a degree because technologies as noted must typically be adapted for localized needs and requirements, a process in itself often requiring IPR protection. However, it does draw attention to a second and generally less recognized aspect of IPRs: its ramifications for access to protected creations (see Lesser, 1991, Chap. 4; Primo-Braga, 1989; Gutterman, 1993). It is in this context that the Convention's focus on technology transfer can be understood.

In general, it is difficult to predict the effect of IPRs on access. Private firms would understandably be unwilling to transfer technologies to countries where IPR legislation was considered inadequate, and all the more unwilling if the possibility existed of fostering competition in a third market. In that context, it needs to be noted that IPRs are strictly national law; they apply only where IPRs are available and where they have been secured. Hence, while IPR owners may sometimes refer to the use of their technologies in countries where patents are not held as "piracy," strictly speaking such use would be perfectly legal

Companies are especially reluctant to transfer easily copied technologies, such as pharmaceuticals and open pollinated plants. However, it is difficult to prevent access to those products, particularly to seeds. Therefore, some companies may seek to license those technologies under the strategy that some return is preferable to none. The balance between those considerations, that is to say the net effect on transfer, is not well documented in the literature (but see Section 4.2 below). Overall, it seems likely that firms will delay the transfer to countries that do not have IPR systems, if only by treating them as a lower priority than countries offering stronger protection.

A different set of considerations arises when technologies are difficult to copy. This would apply to many complex processes. In those cases, copying is often slow and inefficient because the developers do not publicly reveal much of their technology. That information would be provided under a licensing agreement. The use of secrecy indicates that IPRs are but one means of protection; secrecy can often be used as well. For example, firms may transfer technology only to their subsidiaries, or may work only under contract. Plantations would be a means for maintaining control over agricultural technologies. The net effect of weak or absent IPR can then be anticipated to be delayed access to new technologies, or access under limited conditions, such as only through subsidiaries or contractees. In individual cases numerous considerations come to bear so the outcome would be very difficult to predict.

2.5 Conclusions

Technology is the application of knowledge to solving specific problems or to meeting identified needs; technology transfer is the application of technologies in new geo-

graphic or product areas, generally involving adaptation to local needs and conditions. Under the Convention, relevant technologies are identified as a (one) means of helping to achieve the objectives of conservation and sustainable use. Technology transfer is identified as the means of providing broad access in an interdependent world. Specific connection to the objectives of the Convention can be drawn by noting that many relevant technologies are likely to be protected by IPRs, such that the recognition of those rights becomes an aspect of technology transfer. It is for this reason that IPRs receive special consideration in this paper. However, that issue alone is too narrow, for it excludes considerations for buyers as well as for providers of non-protected technologies, including local and indigenous peoples. For that reason the issues of equity and fairness and related matters must be considered to provide a fuller view of technology transfer under the Convention.

Biotechnology requires some further attention if only because of its specific references within the Convention. Biotechnology, as used therein, applies to products rather than processes; products with diffuse but as yet unproven potential. For that reason, biotechnology cannot be treated as a single entity, but rather must be addressed as a composite of products with specific attributes and transfer processes.

There are two conceptual justifications for IPRs: the personal property argument and incentive mechanism use. Modern IPR systems typically emphasize the incentive factor. The Convention, however, by emphasizing transfer, implicitly focuses on existing technologies so that it is the access role of IPRs which would be more relevant. Access is less well studied, and difficult to project in general. Several competing forces exist depending on the specific technology, the fear of losing control of a technology versus the impossibility of maintaining long term control, and the potential for using secrecy/physical control as a protective mechanism. Overall, limited IPRs probably means delayed access with other, if less visible, costs.

3. Forms and Operation of Traditional IPR Systems

Section 2 concluded that absent or limited legislation regarding IPRs would be expected to delay access to new technologies, especially easily copied ones, which would include much of the biotechnology applications. The purpose of this section is to provide a more detailed examination of IPR forms and functions as they apply to technology transfer under the Convention.

IPR systems traditionally include five forms of legislation: patents, Plant Breeders' Rights, copyright, trademarks, and trade secrets. Of those, patents, PBRs, trademark and trade secrets, both singly and combined, are directly applicable to applications under the Convention and receive attention here. This is done in Section 3.1. Other more recent and specific forms of IPR exist as well, including those for maskworks (computer chips), but are excluded as irrelevant to the subject under study.

Section 3.2. contains an examination of the literature on the actual effects of IPR legislation. That information is of importance because under the Trade-Related Aspects of Intellectual Property Rights Agreement of the Uruguay Round of GATT (General Agreement on Tariffs and Trade; now the World Trade Organization), many of the same countries that signed the Convention on Biological Diversity also committed themselves to achieving a specified minimal level of IPR protection. Those changes, once implemented in the mandated five- to ten-year time frame, will not fundamentally affect the technology transfer issues under the Convention. The following section (Section 4) examines how these traditional IPR systems apply to cooperative (as opposed to institutional) innovation and examines what is referred to as nontraditional forms of IPR, for their likely effects on the technology transfer goals under the Convention.

3.1 Forms of Traditional IPR Relevant to the Convention

Patents: Patents, like other forms of IPR, operate as a balance between the inventor and society. Society grants a temporary, partial monopoly to the inventor. Temporary refers to the duration of protection, generally about 20 years; and partial describes the scope of protection, the degree of difference required before a related development is not covered by the patent. What society receives in exchange is more investment than it is expected would otherwise occur and the revealing (disclosure) of the invention. A typical patentability requirement is disclosure "in such full, clear and concise and exact terms as to enable any person skilled in the art or science to which it appertains . . . to make, construct, compound or use it." When, for living matter, a written description is judged in-

sufficient, a deposit may be required (Straus and Moufang, 1990). Disclosure not only permits competition soon after a patent lapses but also provides a storehouse of technical knowledge which otherwise would not exist.

An additional patentability requirement is novelty; the invention must not be previously known. Finally and perhaps best known, the invention must not be an obvious extension of what already exists. This is known as the non-obviousness or inventive step requirement. The requirements are specific and exacting, and there must be human intervention in the inventive process. Examples of human intervention are the purification of a strain of microbes, or the identification of an especially rare rose mutant. The mere identification of something existing in nature (technically known as discovery as opposed to patentable inventions) would not be sufficient for a patent.

To identify a hypothetical case, a specific patent in rice would not apply to all rice. Rather, the application would apply to rice with certain characteristics, such as the built-in insecticide *Bacillus thuringiensis*. Recently, Agracetus in the USA has received much negative publicity for a granted patent (subsequently revoked) covering the genetic transformation of cotton. Technically, this is known as a product-by-process patent, while what is described in the previous example is a product patent.

Plant Breeders' Rights: Plant Breeders' Rights is a specialized patent-like system for cultivated plants. PBRs were first systematized in 1961 under the International Union for the Protection of New Varieties of Plants (UPOV). At the time of writing, there are 30 members, only four of which are developing countries (South Africa, Argentina, Chile, and Uruguay). Membership is pending for Columbia, while India, Pakistan, and The Philippines could join at any time. Still others, minimally Kenya, Taiwan, and Peru, have national laws, but the degree of their implementation is not known. UPOV membership, among other steps, requires that signatories adopt national legislation along the lines of UPOV Convention.

In place of the novelty, non-obviousness, and utility requirements of patent law, PBRs use distinctness, uniformity, and stability (DUS). Uniformity and stability are measures of reproducibility true-to-form, respectively among specimens within a planting as well as between generations. The principal test then is distinctness, that the variety be "clearly distinguishable" from all "known varieties". The DUS attributes are (except in the USA) generally measured in growouts of the planting materials.

PBRs are further distinguishable from patents by the allowance of so-called "farmers' privilege" and "research exemption," sometimes called "breeders' privilege." The farmers' privilege is the right to hold materials as a seed source for subsequent seasons (farmer saved-seed or bin competition), something which would generally be an infringement with patented materials. The research exemption refers to the right to use protected materials as the basis for developing a new variety or other research use. Research or experimentation under patents is not as well defined but is generally believed to be fairly broad.

Because of these differences, PBRs are generally considered to provide less protection than patents. They also apply to the whole plant or the propagating materials thereof. What they do not protect is the distinguishing characteristic of the variety. For that reason, no real protection is provided for a variety with a bioengineered gene which can be moved legally and used in another variety or with another distinguishing attribute added.

That situation will change under the 1991 UPOV text which in Article 14(5) allows for dependency. While experimental use remains unrestricted, a variety determined to be dependent on an "initial variety" cannot be commercialized without the permission of the initial variety's owner. To be dependent, a variety must be "predominately derived." It may be obtained by selection, backcrossing, genetic transformation, or other specifically identified procedures. The actual interpretation of these general concepts is unclear and will probably remain so until there have been actual cases (see Rasmussen, 1990). Through 1995 countries had the option of selecting this or the 1978 text; following that time period only the 1991 Convention will remain open. The 1991 text further allows (but does not require) countries to restrict the farmers' privilege. To date, the USA will not do so, but the European Union is considering limits on larger farmers.

Trade Secrets: Trade secrets, to describe them in their simplest terms, assist in the maintenance of secrets by imposing penalties (the recovering of costs) when information held as secret is improperly acquired or used. Examples of trade secrets include customer lists and practices for improving the efficiency of a breeding process. An employee going to work for a competitor typically would be enjoined from revealing sensitive information for a specified period. Unlike patents and the like, no formal application procedure is needed for a trade secret; rather the information must have some commercial value, and an effort be made to keep it secret. As long as these conditions are met, protection can be permanent.

Within agriculture, F_1 hybrids may be considered a form of trade secret. As long as the crosses and/or the pure lines are protected, the product is difficult to copy. However, the self-reproducible nature of most living organisms precludes a major role for agricultural products. In other technological areas, trade secrets may substitute for, or complement, patents and PBRs. When a product or process is difficult to copy, then trade secrets can be a substitute.

Trademarks: Trademarks are the reservation of a word, symbol, or phrase in association with a product or service. In effect the trademark name represents the product to consumers, justifying an investment in its identification. From a theoretical and economic perspective, trademarks assist customers in identifying products of consistent, often high quality. Trademarks are permanent as long as they remain in use, are identified as such, and do not acquire a generic connotation. Often a trademark, such as Coca-Cola, is the most valuable asset of a corporation.

Within agriculture, trademarks can be associated with products at the firm level (Pioneer Hi-Bred), or individual products such as the FlavrSavr™ tomato. Note that the tomato variety, McGregor®, is also protected, so the two forms of IPR are, in that instance, complementary. At the plant variety level, the role could be more of a substitute than complement. Because of the farmers' privilege and research exemption under PBRs, Lesser (1987a) has previously argued that in the USA, the PBR law really protects the variety name rather than the germplasm itself. Hence there is a degree of substitutability between trademarks and PBRs. The same would not apply to patents because of the emphasis there on identified novel characteristics rather than the entire plant.

3.2 Evidence on the Implications of IPRs

As was discussed in Section 2.4, IPRs are primarily a form of economic policy intended to advance the production and use of new products and technologies. That, however, is but the promise. This subsection explores the available information on what is known about the practical results of the legislation in the areas of investment and access. The available information is anything but complete, but it is all that is presently available for planning purposes.

Investment (R&D): Since the major justification for IPRs is the attraction of funds for research and development (R&D), it seems a reasonable question to examine the evidence from actual experiences (this material is drawn principally from Lesser, 1991). For patents covering all technologies what is known is inconclusive. The analytical complication is largely methodological, attempting to determine what would have happened in the absence of the legislation. Additionally, for many technologies, other forms of protection can serve as a partial substitute for patents. Surveys of business leaders typically place a low ranking on patents as a stimulant for R&D investment (Nogues, 1990, pp. 11-14).

When specific sectors are examined the results become more definitive. In general it is recognized that patent protection is especially important for pharmaceutical products and for living organisms. Both are relatively expensive to develop and easy to copy. A major cost is that of satisfying regulatory requirements. For pharmaceuticals in the USA, clinical trials are said to use the bulk of the $250 million per product development cost, and the preparation of a food safety dossier for a genetically engineered food costs around $1 million. One source of information on the role of patents is the implications of the removal of protection. In India, pharmaceutical R&D fell a total of 40 percent from 1964-70 to 1980-81, something Deolalikar and Evenson (1990, p. 237) attribute to the weakening of patent protection in 1970.

An ancillary point, and one particularly relevant to agricultural applications, is that of adaptive research. Deolalikar and Evenson (1990, p. 251), again referring to the case of India, conclude, "If anything, the relationship that is often observed is one of complementarity." In Evenson's view (1988, p. 152), "Indirect transfer does not take place without research capacity in the destination country."

A number of more formal economic studies have been conducted on aspects of the patent system, such components as optimal duration and the consequence of the "winner take all" approach (review in Primo-Braga, 1990). Overall, as might be expected, these issues are very sector specific and general studies lead to inconclusive results with limited policy implications. However, indications are that patenting and R&D are not dominated by major firms. Rather, medium sized entrepreneurial firms, which are dependent on technological advantages for their market position, are the market leaders.

Overall, PBRs are relatively more recent and sector specific than patents, which eases the methodological problems in evaluating the impacts. The major study was conducted in the USA in 1980, a decade into the Plant Variety Protection Act (Butler and Marion, 1985). When considering the results, it should be recognized that the

interpretation of the USA of not requiring objective standards for performance claims means the scope of protection in the USA is relatively narrow (see Lesser, 1987a). Despite these caveats, it was found that PBRs did have a significant impact on private investment and numbers of private breeders, especially in the case of soybeans. Other observers (e.g., Brim, 1987, Tables 3 and 5) have confirmed those results.

More recently for the USA, there are some suggestions that the initial investments by the private sector were over responses, that the actual profits are insufficient to maintain the current investments. The premium for certificates for soybeans in New York State was placed at only 2.3 percent (Lesser, 1994), which is consistent with that position. Moreover some companies, including Stone Seed Company, have not been pursuing PBRs in favor of sales agreements. A typical agreement would read in part, "Purchaser hereby acknowledges that the production from the Stone Brand Seeds herein sold…will not be used or sold for seed, breeding, or any variety improvement purposes." The level of enforceability of these provisions in the USA, not to mention other countries, is not known.

Recently, limited information on the operation of PBRs in other countries has begun to appear. A graphic plot of new variety registrations in South Africa indicates a notable increase following the adoption of PBRs in 1976 (van der Walt, 1994, Table 1). Similarly, a provisional study shows the Argentine private sector increased its investments in plant breeding, but only after the law was enforced (Jaffé and van Wijk, 1995). Hence all available information is consistent with the theoretical expectations that increased IPR protection does indeed lead to greater investment, especially for easily copied products. The more relevant, and difficult, question for the Biodiversity Convention is the implications for access.

Access: The conclusion that PBRs lead to greater internal investment in breeding expenditures leaves some ambiguity regarding the effects on access. Access conceivably could be enhanced, supplanted by recipient country investments, or it could remain unaffected. Many of these are long term issues for which a few countries are just approaching the initial stages. Nonetheless there is some information which suggests that the presence of PBRs does indeed enhance access.

A strong motivation for the adoption of PBRs by Canada in 1990 was access to improve, protected potato varieties from Holland. As well, within Canada there was a reluctance to export varieties to the USA because of the concern that they would be transported back into Canada (Cooper, 1984, p. 47). Young (1989) concluded:

Some private varieties should be available for use in Canada even though they may be created elsewhere as part of the larger plant breeding program, and a consequence of no breeders' rights legislation is a restriction on the availability of such private varieties.

Similarly, cut flower producers experiencing difficulties with accessing new varieties were major proponents of the Colombian national law and subsequent application for succession to UPOV. Uruguay adopted PBRs largely to prevent trade disruptions with Argentina, with which its economy is closely tied (Jaffé and van Wijk, 1995). Overall, Juma and Ojwang (1989, p. 153) recognized that the greatest restriction on the exchange of germplasm is with countries outside the UPOV system.

The evidence for access under patents is more diffuse because of the range of technologies affected. However, Pray (1986, p. 50) found that, "The likelihood of copying represents major barriers to the introduction of new products in India by foreign companies," while McLeland and O'Toole (1987, p. 247) see limited patent protection as one reason why technology imported into Latin America is often out dated.

3.3 Trade-Related Aspects of IPRs (TRIPs)

The TRIPs agreement requires signature states, including some 70 developing countries, to provide for the following protection (MTN/FA II-A1C):

- Contracting parties shall provide for the protection of plant varieties by patents and/or by an effective *sui generis* system (Section 5, Article 27(3b).
- Patents may be prohibited to protect *ordre public* or morality, provided there is a justification exceeding the mere prohibition in domestic law (Section 5, Article 27(2)).
- Plants and animals other than micro-organisms and "essentially biological processes for the production of plants and animals" may be excluded from protection (Section 5, Article 27(3b)).
- Compulsory licenses may be issued in limited cases of due diligence to make a licensing agreement, adequate remuneration, and subject to judicial review (Section 5, Articles 30 and 31).
- For process patents, the burden of proof of infringement may in some specified circumstances be shifted

to the defendant to prove that the patented process was not used (Section 5, Article 34).

- Persons shall have the option of preventing others from using without permission information of commercial value so long as reasonable efforts have been made to keep it secret (Section 7, Article 39).

Even with this legislation, restrictions will remain. For example, the five years (and up to 10 years depending on product and level of development of a given country, with further delays possible on approval) allowed for developing countries to adopt and implement the changes (Part VI, Articles 65 and 66). Moreover, similar terminology to "plants and animals and essentially biological processes for the production of plants or animals" exists in the European Patent Convention (EPC Article 53(b)), but there reference is to "plant or animal *varieties*" (emphasis added). The trend has been to interpret the exclusion narrowly so as to allow patenting which applies, for example, to multiple varieties (see Crespi, 1992). How it will be interpreted with the new terminology is not known at this time, but in all likelihood patents for most life forms (except micro-organisms) will be prohibited in at least some countries. This, however, will not apply to biotechnology processes even when applied to living organisms. Additionally, note that countries may exclude patents which are contrary to "*ordre public* or morality." This terminology exactly parallels the EPC (Article 53(a)), and the European Patent Office has rejected an animal patent on those grounds. This increases the likelihood some developing countries will exclude classes of inventions, living organisms in particular, based on moral objections. TRIPs (Section 3) does require countries to adopt enforcement procedures which are "fair and equitable," are "reasoned" but "not unnecessarily complicated or costly."

All of this says that countries opposed to IPRs may under TRIPs have to make limited changes, and none in the immediate future, unless and until countries are convinced change is to their benefit. And since the great bulk of countries presently with absent or constricted IPR legislation or enforcement are developing countries, the immediate implications of TRIPs for the Biodiversity Convention could be limited. However, within that general conclusion there are more specific matters to consider.

Plant Breeders' Rights: As regards PBRs, TRIPs is quite specific, the allowance of either plant patents or a sui *generis* system for plant varieties, or both. *Sui generis* means separate or independent, as in a distinct form of legal protection. This is widely interpreted to mean Plant Breeders' Rights as in one of the UPOV conventions. That is, UPOV membership, although no specific interpretation has been issued to date, would, in all likelihood, satisfy the commitment.

The other option for countries is the adoption of a national PBR law, as presently exists in several countries. There would be two major considerations in planning such a step. First, TRIPs reads "an effective" *sui generis* system. Just who will be interpreting what constitutes "effective" and on what grounds is not clear at this time. For example, one proposal from India is the incorporation of a form of Farmers' Rights in a national PBR law with other elements more or less closely derived from UPOV 1978 (Swaminathan and Hoon, 1994). Farmers' Rights is a call for payment to traditional farmers for the development and preservation of landraces in particular, which provide the genetic base for many advances in variety development (see FAO Resolution 5/89). Would such a system be judged as "effective"? Probably yes, if the tax rate were not onerous (5% in the case of India).

A second and more enduring matter is the foregoing of UPOV membership benefits. One of the more significant benefits is the relatively straightforward understanding of what the law allows, based on experiences of multiple other countries. Such a textural reading, of course, begs the question of the degree and efficiency of enforcement. The experience in Argentina, for example, was that nothing happened under the law until an enforcement mechanism was implemented (Jaffé and van Wijk, 1995). More significant yet is the concept of national treatment, in short, the prohibition of discrimination against nonnationals (Article 4).

Patents: Unlike PBRs, countries have the right under TRIPs to exclude patents for plants (and animals). Considering the controversial nature of this matter, it seems many might do so, or continue to do so. As of 1988, 54 national patent laws prohibited patenting plant varieties (WIPO, 1990, Annex II). Of course, a large step from the nonexclusion of plant patents to issuance remains. Even with the rapid evolution of views in India, it is difficult to imagine a plant patent emerging there any time soon. PBRs will not suffice to provide protection for genetically engineered plant traits for reasons which can be readily explained. Under the 1978 text of UPOV, any variety which is distinct in one recognized characteristic can receive protection. Thus, if a rice variety bioengineered for pest or disease resistance had improved yield added by a different firm, the improved variety, the second firm would own resistance and all. The dependence stipulation in the UPOV 1991 Convention text would allow more

ownership control by the biotechnology firm (Article 14(5)). If the disease resistant variety were accorded "initial variety" status, derivative varieties could not be commercialized without permission. However, nothing would prevent a firm from removing the responsible genes for transfer to another distinct variety. A combination of 1991 UPOV **and** patents on the genes themselves would seemingly provide protection similar to plant patents.

3.4 Current Status of IPR Protection Worldwide

As of 1988, 53 countries statutorily excluded plants and 54 excluded animals from patent protection (WIPO, 1990, Annex II). These include the members of the European Patent Convention (EPC) which in Article 53(b) excludes patents for "plant or animal varieties and the essentially biological processes for the production of plants and animals". Written in the pre-biotechnology days, the interpretation of that phrase has proven complex over the years. Several patents have been granted bases on an interpretation that "variety" refers to a variety in a "fixed form" so that a development which was applicable across multiple varieties could be patented. Most recently, the European Patent Office appeals ruling on a Plant Genetics System patent rejected coverage for the plant and seeds (EPO, 1995). The significance of that decision will not become clear for some time. The bulk of the other countries are developing nations, many of which have language similar to the EPC.

As noted, there are presently 30 members of UPOV, with all but Argentina, Chili, Uruguay, and South Africa being developed countries. A number of additional countries have national PBR laws, including Colombia, Taiwan, Kenya, and Chile, among others. Details on the operation of those laws are limited.

Membership in a national convention standardizes the conditions of protection to a large degree. Standardization of patent and trademark laws is assured in part by the Paris Convention of 1883 with its 100 plus members. Among the key provisions are *national treatment* which stipulates that foreigners must be granted the same rights as nationals. Additionally, the right of priority stipulates that an application filed in any member country establishes that filing date for all other countries for a period of one year. The filing date is critical for the bulk of countries which follow the *first-to-file* system. The major difference is the USA which uses the first-to-*invent procedure* (see Lesser, 1987b). The World Intellectual Property Organization (WIPO), a specialized agency of the United Nations, which oversees administrative and harmonization responsibilities administer the Paris Convention. The Paris Convention also sets limits on conditions for compulsory licenses; rules which allow rights to third parties to license patented technologies.

The final major difference in worldwide patent laws is the form and duration of the *grace period*, the time between the publicizing of an invention and the initial filing of a patent application. These range from none in the EPC member countries to one year in the USA (Lesser, 1987b). Recent efforts for further patent harmonization broke down, but GATT imposes some standardization, such as setting the patent duration at 20 years from the first filing.

3.5 Conclusions

Four forms of "traditional" IPR legislation are applicable to protecting the kinds of technologies implied in Articles 16 and 18 of the Convention, including biotechnologies. These four, which can be used separately or jointly, include patents, Plant Breeders' Rights, trademarks, and trade secrets. Each is intended for a particular function and as such has specific attributes and exacting granting requirements. Certainly it is not possible to protect every form of innovation. As noted, IPRs are intended principally to foster private R&D. The available evidence generally supports that expectation; IPRs do indeed encourage investment by the private sector, especially for easily-copied inventions. The evidence, however, is fragmentary and will not convince all readers, in part because IPR is but one means of protecting inventions. Maintaining physical control, or secrecy, can be used as well in many instances. According to the available evidence, IPR, nevertheless, is an important component of an incentive system.

A secondary function of IPRs is to encourage access to inventions produced elsewhere. This aspect is particularly significant to the Convention because of the emphasis there on access and transfer. In general there is less evidence regarding the IPR implications for access than on R&D incentive. This is especially true because many inventions are nearly impossible to prevent from moving internationally, seeds being a case in point. Nonetheless the evidence, while limited, does indicate that appropriate IPRs do facilitate access, a factor which was a principal motivation for its adoption in many countries. IPR systems have costs, royalty payments being the most obvious, but the costs of the absence of protection in terms of denied or delayed access must be determined on a case-by-case basis.

Patent laws exist in over 100 countries; PBRs in 30; but no international tabulation of trade secrets exists. The raw figures, however, do not give a complete indication of the status of protection. Approximately 50 countries specifically exclude plants and animals from patent protection, although there has been some patenting made possible by a narrow interpretation of the exclusion. On the other hand, the number of countries with PBR legislation, especially members of UPOV, has been growing rapidly. This is due at least in part to the Trade-Related Aspects of Intellectual Property Rights agreement under GATT which specifies certain minimal levels of protection be adopted within five to ten years. In particular, signatory countries must have in place either PBR or patents or both for plants. Most at present are opting for PBR, although it seems to offer incomplete protection for bioengineered plants.

4. IPRs and Cooperative Technology

The preceding section described the operation and relationship between traditional IPRs and technology transfer. That analysis, by drawing on the literature in the academic and business press, applies to what is referred to here as "institutional innovations," those made using contemporary scientific and engineering procedures. Within the Convention, however, there is no reason to be so limiting in the sources of the technologies which might be transferred. In particular, the Convention sanctions the promotion of the "wider application" of "innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity." Since "innovations and practices" is a synonym to the definition of technology used here, this class of technologies, referred to here as "cooperative technologies," should also be evaluated for the roles of IPRs in technology transfer.

The purpose of this section then is to examine the applicability of IPRs to cooperative innovation and subsequently on the transfer of those innovations. The analysis begins with an overview of the conceptual relationships of contemporary IPR law and cooperative technologies, followed by an assessment of those traditional forms of IPR considered in Section 3. It then progresses to more novel means of achieving the same general goals of technology enhancement and transfer.

4.1 Conceptual Relationship of Contemporary IPR Law and Cooperative Innovations

As a starting place it is instructive to examine if there are any conceptual, or even philosophical impediments to applying IPRs to cooperative innovations. For that purpose a reference to the historical development of IPR laws is appropriate (history in Walterscheid, 1994a and 1994b).

The term "patent" originates from *letters patents*, or open letters dating to early in the 13th century which were used by the kings of England to conduct business and to confer privileges. However, it was not until the middle of the 19th century that these concepts were extended beyond their physical manifestations to intellectual concepts, the ideas underlying their creations. To accomplish that extension, three fundamental societal transformations had to be realized. First, societies had to be secularized to the extent that genius was perceived as a personal trait, not a divine gift, for how could profit be drawn from a gift of God?

Second, intellectual products had to be recognized as having commercial value in their own right. For establishing that principle, the guilds of the Middle Ages were instrumental. Guilds—the glass makers of Venice are a key example—attempted to retain their technical knowledge within their countries and even within certain members of a guild, thereby limiting competition. Indeed, guilds were nothing more than group monopolies sanctioned by the state.

Finally, private rights needed to be distinguished from those of sovereigns. This was done under mercantilism, when kings granted monopolies to attract national industry and extended monopolies from processes to particular production activities. The term "invention" itself encompassed importation of procedures in addition to actual discovery. Yet the monopoly extended only to the right to produce, not to market, with the king retaining the royal prerogative to reward by issuing privilege. However, that power became corrupted as rights were extended to monopolies over production, then transportation and importation, and finally to existing industries with no pretense of invention, even under the broad interpretation. Those "Odious Monopolies" became increasingly unacceptable to Parliament which in 1623 passed the Statute of Monopolies. That Statute banned all prior granted and future monopolies with the exception (Section 6) of those "to the true and first inventor," leading to the modern concept of patents as a societal trade-

off of partial monopoly for some potential public commercial benefit.

The preceding, while recognizing the wide differences in time and situation, nevertheless contains several lessons for the present situation. Of particular significance, IPRs apply only when the concepts of commercial value and intellectual contribution are established. The former has been long delayed for natural products by the view of genetic resources as being the "common heritage of mankind" (Nijar and Ling, 1994). Like genius, how can commercial gain be sought from something which is provided by God? Only recently has the realization become widespread that natural materials are indeed preserved, and shaped, by people who may legitimately seek financial rewards for those efforts (Mooney, 1992). Moreover, it is the intellectual additions to those materials, the knowledge of use, which has value distinct from the physical products themselves. This too is recent for that application but conceptually parallels developments in the European Middle Ages regarding the valuation of knowledge.

It can be seen that there are no fundamental contradictions between the concept of IPR law and their extension to the creations of traditional peoples. Indeed, early European applications were to groups and guilds, an issue with community-based knowledge. IPR law, however, is more than a concept; it is a body of statutes. It is the applicability of those statutes to cooperative innovations to which we turn next.

4.2 Strengths and Limitations of Traditional IPRs Applied to Cooperative Innovations

There is no reason why cooperative innovations could not occur in any technological area; human ingenuity has no known limits. However as a practical matter under the Convention, references to IPRs are to genetic resources and to conservation-enhancing technologies, such as bioremediation. Hence in the interest of making this assessment as practical as possible, it is desirable to focus on the applicability of IPRs to genetic resources, including landraces, as major areas for cooperative technology development. Of course, such subject areas include the knowledge associated with those materials.

Patents: Genetic resources patents may be sought in the form of the entire organism (micro-organism, plant) or parts thereof, such as a gene complex, provided there is some human input. In general, the patenting of genes (except human genes) is not a legal problem; indeed, it is not entirely clear that genes would be treated as living organisms. Similarly, many countries allow patents for micro-organisms, and TRIPs specifies that micro-organisms may not be excluded from patent protection (see Section 4.3). Seeds/plants are a more complex matter, and animals yet more so.

Seeds are patentable subject matter in the USA and provisionally patentable elsewhere. There is no inherent reason why genetic materials of agricultural, pharmaceutical, and other uses would not likewise be patentable, at least in concept. The fact that the materials are identified in the wild rather than purposely invented is not a legal hindrance. Precedence has been established with patenting micro-organisms identified in the wild as long as the application is in a "culturally pure" form to reflect human intervention (see Bent *et al.*, 1987). Indeed, what is really being protected is the human knowledge of how the organism is to be used. The other patent requirements must be fulfilled as well. Nor does the fact that, when required, regenerating a plant *de novo* from the technical description is difficult and expensive, if possible at all, pose an absolute barrier to patenting under the disclosure requirement. In such cases, a deposit is generally required (Straus and Moufang, 1990). Thus there is nothing fundamental which prevents the patenting of these materials where seeds and plants in general are patentable. Many of the same conclusions can be reached for animals, although the technical issues are often more complex.

The hindrance is instead a practical matter. Patents are not granted for a plant in its entirety, but for a plant or other product with unique characteristics, as specified in the patent claims (US Dept. of Commerce, 1983). In the past those attributes have been elevated triptophane levels, herbicide resistance and the like among agricultural applications, attributes introduced/induced through technological procedures. It is likely some landraces have such unique attributes—one traditional potato variety, for example, has hairy leaves which aid in aphid (hence virus) resistance—but certainly not all. For pharmaceutical and industrial applications, generally a genetic sequence is identified and removed from the source organism. Identifying and characterizing such traits at the level required by patent offices is a significant task, certainly beyond the means of local communities and, given the particular requirements of patent applications, exceeding the expertise in many countries. A final consideration is the cost of preparing an application, about $US 20,000 for a US application and twice that in Europe (due to translation charges) (Abbott, 1993). Proposals have been made for some kind of international fund and/or ombudsman role

to assist with application costs (UNDP, 1994); Gupta is attempting to implement the approach for India. However, while it may be possible to locate funding for processing some patent applications, that procedure would not be feasible for large numbers of materials which had not been carefully screened, implying a very low probability of commercializable products (see Weiss, 1995; Principe, 1988). Thus patents are not practical for protecting genetic materials in bulk, although they may be used in certain cases, where permitted.

Another category of patents with some useful attributes is petty patents (alternatively called utility models). Petty patents are, in effect, a weaker form of patent for more modest inventions. They are distinct because the duration is typically up to 10 years as opposed to around 20, and the standard for the invention (the inventive step requirement) is typically lower. Thus applying for and receiving a petty patent is generally less expensive than for a full patent, although the royalty rate would, as a result, be expected to be lower as well. The Japanese system has the added option of switching from a petty to a regular patent application. That provides additional flexibility. Studies of petty patent systems indicate that they are effective in encouraging investment at the local level in developing countries (Evenson, Evenson and Putnam, 1987).

The principal limitation with petty patents is that they are usually designed for and specifically limited to manufacturing products. The Japanese utility model law for example reads, "shape or construction of articles or combination of articles so as to contribute to the development of industry" (Law No. 123, 1959, Section I.1). For developing countries, a plow design would be an example. Kenya is an example of an innovative system where petty patents have recently been allowed for traditional medicinal knowledge (Gollin, 1993). That system should be studied for possible application elsewhere.

Plant Breeders' Rights: Plant Breeders' Rights as embodied in UPOV are a form of patent-like protection expressly for plants. There are some technical differences which as a general matter make the extent of protection less broad than for a patent. However PBR, while referring to one or more distinct attributes of the plant, apply to the whole plant. PBR are relatively easy and inexpensive to apply for, costing about one tenth the amount of a patent (Plowman, 1993). PBR include a specific research exemption which provides good access to protected materials. Furthermore, varieties discovered in the wild are protectable with PBR, although some breeding would typically be required to satisfy the homogeneity and stability requirements (Straus, 1988; Juma and Ojwang, 1989). Hence, PBR would seem to apply to many of the needs for protecting genetic materials in agriculture. UPOV is not intended to protect plants in general as is made evident from the list of genera to be protected under the 1961 UPOV Act (Article 4(3)). For example, it would not generally be applicable to wild plants used for pharmaceutical purposes.

Where PBRs fail, or would seem to fail, even for agricultural uses, is in not providing remuneration under either the 1978 (and earlier) Act or the 1991 version which introduces "dependence." Under the earlier versions, a variety which is bred from a protected variety is not infringing (owes no royalties) as long as the new variety is distinct according to the UPOV interpretation. If the protected variety is a landrace which is used (as is permitted under the research exemption) in a breeding program—a general case because landraces seldom are acceptable for commercial-type farming operations—the resultant new variety or varieties would receive the sales with no payments owing to the owner of the landrace.

The 1991 UPOV Act rectifies that situation in part by differentiating between initial and essentially derived varieties, with essentially derived varieties requiring permission for marketing from the owner of the protected variety. In most cases that permission would be granted for a royalty fee. However, UPOV Article 14(5) establishes two conditions for derived varieties: that they be "predominately derived . . . while retaining the expression of the essential characteristics." As an example, the essential characteristic could be disease resistance found in a landrace. In the breeding process, the remaining (undesirable) genetic material would be bred out so that the genetic composition of the resulting commercial variety would be predominately from another source. That would seem to preclude its being established as an initial variety under the proposed interpretations. Those interpretations also specify the existence of a single initial variety for any derived variety (UPOV, 1992). The interpretations are advisory only, and eventual national applications could be more favorable to PBR use for landraces. This is something for national governments to consider.

Trade Secrets: Trade secret legislation allows those whose industrial secrets have been improperly acquired to use the courts to stop further use and/or seek restitution. They would apply if an employee changed employment to that of a competitor, there revealing the production secrets of the former employer. Or trade secret legislation would apply to outright theft, in general any case in which (1) the

item or information had value, and (2) an effort was made to keep it secret. The community aspect of much cooperative technology makes secrecy problematic, and indeed secrecy would be contrary to the open exchange considered necessary for maximizing advances within agriculture. Thus trade secret legislation is not really applicable.

Overall then, traditional forms of IPR are not applicable to the major forms of cooperative technologies; certainly critics of IPR are correct in that regard (UNDP, 1994). Attention is directed next to alternative forms of IPR referred top here as "nontraditional."

4.3 Alternative Forms of IPR

IPRs, as is suggested above, are but one means, and not a very applicable means, of claiming control of and remuneration from cooperative technologies. Other possible approaches to be considered here include "Farmers' Rights," treatments of folklore, codes of conduct, and appellations of origin. For a broader group, see Posey (1994).

Farmers' Rights: Farmers' Rights is the term developed by the FAO under the so-called Revised Undertaking for Plant Genetic Resources. While not necessarily restricted to plants with agricultural applications, it is quite evident that is the intended focus of the Undertaking. In Resolution 5/89 Farmers' Rights are defined as "rights arising from the past, present and future contributions of farmers in conserving, improving and making available plant genetic resources . . ." Farmers' Rights are to be "implemented through an international fund on plant genetic resources which will support plant genetic conservation and utilization programs, particularly, but not exclusively, in the developing countries." (FAO Resolution 3/91, Annex 3 to the International Undertaking). No further details on the implementation and operation of this fund are included.

In concept, Farmers' Rights operate more as a moral obligation than an economic incentive. They are not connected with any specific future action but rather with a general conservation and equity objective. Thus Farmers' Rights are noted without prejudice but only to emphasize that the objectives, and hence the likely results, of the system are quite different from IPR. However one parallel which has been drawn on several occasions (e.g., UNDP, 1994) is to blank recording tapes and other selected applications. The reasonable presumption is drawn that individuals will make copies, thereby denying authors and artists royalties. The fund compensates those losses on some formalized basis; presumably the nationality and residence of the recipient would make no difference. A similar approach could be used for seeds and other genetic resources.

Perhaps the major comment which can be made is the lack of action on the fund since its proposal. The time span has been relatively short, but there are few indications to date that such a fund will be constructed, at least under these specific auspices. The entire International Undertaking process received much negative attention in the developed countries early on due to the interpretation of "plant genetic resources" to refer to both unimproved and improved genetic materials (Article 5) (see Grossman, 1988). Private firms have not made their products available without charge, and while it is a matter of interpretation if that was specifically required by the Undertaking, it did poison the atmosphere. Subsequently, the proposed tax on seed sales was never supported. The 1996 technical meeting in Leipzig was, however, well received and future course of action identified although trade issues were conspicuously postponed for later consideration.

It is possible, of course, that the concept of Farmers' Rights could be pursued more readily under a different name and institutional structure, possibly the Biodiversity Convention. For the present, implementation may come in India where one proposal for PBR legislation calls for Farmers' Rights (Swaminathan and Hoon, 1994, Articles 8, 9, and 23). However, because of the national form of that proposed language (as with all IPR legislation), the India-only system is effectively a national five percent gross seed tax with the funds to be returned to rural and tribal families contributing genes where identifiable, otherwise to a Community Gene Fund.

Folklore: Many of the issues associated with protecting genetic materials have parallels in protecting expressions of folklore. That is particularly true of landraces which, like folkloric expressions, are the result of long term community contributions. Like landraces, there is no system of compensating, or even acknowledging, those communities for their contributions. The applicable IPR systems, copyright and trademark, operate similarly to patents in requiring new and unique creations, which folklore does not. Perhaps attempts to protect folklore will provide some insights for use with genetic materials.

Treatments of IPR for folklore culminated in the joint 1985 "Model Provisions for National Laws" by WIPO and

UNESCO (WIPO, 1985). There, the expressions of folklore are defined as "characteristic elements of the traditional artistic heritage developed and maintained by a community . . . or by individuals reflecting the traditional artistic expectations of such a community." These expressions may be verbal (folk tales), musical or action (dances) as well as tangible expressions like art, musical instruments and architectural forms (Model Law, Section 2). When used "with gainful intent outside their traditional or customary context" such expressions are "subject to authorization" by the competent authority of the community (Section 3). The expressions may originate from the community or elsewhere, provided they were subsequently further developed, adopted, or maintained through generations (Par. 35).

As can readily be appreciated, the issues are indeed similar to those for selected cooperative technologies like landraces. However no helpful detail is included on how to implement what can only be described as concepts. For example, in the frequent situation where neighboring communities practice slight variants of the same tradition, whose permission would be required, any one of the communities, or some/all of them? How or who would determine when an expression is different enough to be a separate form of expression? What competent authorities would be identified to represent a community? And what constitutes an "artistic heritage?"

Hence, the protection of folklore has moved little beyond the conceptual stage, not far beyond cooperative technologies.

Codes of Conduct: Codes of conduct refer to standardized but voluntary agreements specifying obligations. They are similar to a one-sided contract voluntarily entered (compare with, for example, Downes *et al.*, 1993). The FAO has over several years prepared a "Code of Conduct for Plant Germplasm Collecting and Transfer," still in draft form, which could serve as a model for protecting some cooperative technologies (FAO, 1993).

The Code, which is directed primarily to governments, has the principal objectives of promoting respect for the environment and local traditions and cultures, and establishing mechanisms for compensating local communities and farmers for their conservation and development activities (Article 1). The mechanism for achieving these goals is to require collection permits (Article 8) subject to certain conditions, including "financial obligations," restrictions on the distribution or use of the germplasm or improved materials derived from it, the use of care in the collection process, and provision for duplicate sets of the collected materials on request of the country (Articles 8, 10 and 11).

Separate obligations apply to sponsors (see "to degree possible collectors abide by Code," Article 12), curators (provision of further samples, Article 13) and users ("consider providing some form of compensation," Article 14). This Code is seen as serving temporarily until national legislation is passed or possibly a legally binding international agreement like a protocol under the Biodiversity Convention is reached. For the present, the Code can be seen in part as a model law for national governments. In its present form of a voluntary guideline, it has limited utility.

Appellations of Origin: Appellations of Origin are coordinated by the Lisbon Agreement of 1958, which, with its 17 members, is administered by WIPO. The Agreement (Article 2) defines applications of origin as the "geographical name of a country, region or locality, which serves to designate a product originating therein, the quality and characteristics of which are due exclusively or essentially to the geographical environment, including natural and human factors." The prototypical example is champagne from the region of the same name in northeastern France.

Extensions of this IPR approach to cooperative technologies are as yet untested. But the definition implies a quasi-finished product which can be identified and distinguished by users. From that perspective, the concept would not seem to apply well to many cooperative technologies. On the other hand, living material, such as wine grapes, are affected by growing conditions so that useful distinctions could be made for selected cooperative technologies. This would seem to apply best to such manufactured products as cosmetics which use a combination of natural products for the overall effect, as opposed to pharmaceutical products where the causal agents, genes in the case of many cooperative technologies, must be characterized in detail. Hence there may be some scope for appellations of origin application for cooperative technologies.

4.4 Conclusions

Those who complain of a double standard regarding the IPR protection of genetic materials have a legitimate position (e.g., UNDP, 1994; ACTS, 1993; Greaves, 1994). Conceptually, IPR protection for cooperative technologies in the areas of genetic resources and landraces fits

smoothly within the historical development of IPR legislation. Practically speaking, however, current legislation is applicable to improved plant varieties but is not really suited to landraces and the like, even though they are technically protectable. The closest that current law comes to effective protection is the 1991 UPOV text. However to be useful, a quite different interpretation of the attributes of a derived variety (possibly involving a textual change) would be required. That option should be considered, but it could be a difficult and lengthy process. For other materials, patents are usable, but the costs of documenting and preparing an application make patents a prohibitive approach for the great bulk of materials of uncertain use and value, even if some funding system were established. Overall then, traditional IPR is not broadly useful for cooperative inventions.

When the assessment is enlarged to include "non-traditional" forms of IPR, Farmers' Rights and folklore, while interesting concepts, are in their present forms not fully developed for the protection of cooperative technologies. Appellations of origin have promise in some product areas, such as cosmetics, but would take creative adaptation, and would be limited at minimum. The FAO Code of Conduct is less a form of IPR and more a model contract. The application of contracts will be discussed further in Section 6.

Clearly, if IPR is not widely applicable to cooperative inventions, then it is ineffectual in aiding either the creation/preservation of cooperative technologies or the transfer of those technologies. In the past, access to those technologies has been readily available under the models of free access and the common heritage of mankind. That era is evolving to a period of less access, or at least access on different terms. Evidence is shown by the calls of some groups for national and/or international bans on the exchange of cooperative technologies until countries have established access laws including commercialization and sharing arrangements. Most recently, the Government of India proposed barring the USA access to its genetic resources until and unless it ratified the Convention.

Section 5 returns to other aspects of the IPR/ technology transfer issue—those of fairness and equity.

5. Equity Considerations in Technology Transfer

The preceding sections identified the roles of IPR in technology transfer, but noted that the conclusions related only to the efficacy of transfer, not its equity. Equity is an objective in its own right, with a specific objective of the Convention stated as "fair and equitable" and "equitable sharing" (Articles 15(7) and 8(j)). The purpose of this section is the evaluation of this terminology in the context of technology transfer, both for institutional and cooperative technologies.

5.1 Perspectives on What Constitutes "Fair and Equitable"

The terms fair and equitable have culturally, even personally, based interpretations making it difficult to define when that state has been reached, or even to recognize it after the fact. As a practical matter, this makes it tenuous to conclude any commercial agreements on technology transfer. It also makes it difficult to discuss the subject in a constructive manner for there may be unstated differences in the understanding of what constitutes "fair and equitable." Here four possible perspectives on fairness and equity are evaluated, with the significance for technology transfer discussed in the following subsection, Section 5.2.

The four perspectives considered here are:

- ability to pay,
- fair share,
- no harm done, and
- marginal value.

This group is by no means exhaustive but does contain major approaches. Equity and fairness must be evaluated in comparison to some norm, called "welfare." Welfare may be determined for groups, known as social welfare, or for individuals. Changes which enhance social welfare are, for purposes here, by definition ethical, and vice versa. The major issue arises in terms of how welfare is calculated. Conceptually, there are two major approaches. The first, which incorporates ability to pay and fair share from our list, is based on a judgment-derived social welfare function. Developing such a function requires value judgments be explained in interpersonal terms. Those who believe a dollar is "worth" more to the poor than the rich are making interpersonal judgments. No matter how reasonable that expectation of the poor enjoying money more than the rich may appear to be, there is no substantive evidence to support its universality; it is a value judgment.

The second approach, which incorporates our identified concepts of no harm done and marginal value, is free of such value judgments regarding interpersonal value judgments. However, it does have the attribute of assuming welfare changes are independent of the underlying distribution of income. Under this approach, there are no rich and poor people; their financial status is irrelevant for welfare considerations. The consequences of this for technology transfer considerations are discussed below.

The major point to be made here is that true equity issues can be described best in terms of implications for income distribution. However, establishing international agreement on the appropriate distribution remains extremely difficult, to say the least. Not only are there differences in personal, national, and religious-based values which must be incorporated, but individuals who have benefited by past arrangements understandably wish to maintain them while those who have been excluded seek to change.

Speaking in broad generalities, residents of the ten poorest countries and their spokespersons, countries which garner 2 percent of the world GNP with 5 percent of world population, seek a larger share. Conversely, inhabitants of the ten richest developed countries, which enjoy 60 percent of world GNP with only 10 percent of the population generally believe they have "earned" the right to a higher standard of living. Both feel they are morally justified in their positions, meaning an agreement is elusive. For this reason, it is difficult to develop broad support for value-based decisions so that the second category of "value free" approaches to equity can provide a pragmatic, short term basis for making choices. No one can claim they satisfy all aspects of "equity," but they do provide a systematic basis for satisfying at least some equity concerns. While this discussion is presented in terms of income distribution, this should not be taken as an inference that income is the only or even the most important equity issue.

With Interpersonal Comparisons:

Ability to Pay: Ability to pay concepts underlie so-called progressive income tax systems under which higher income individuals pay a greater share of their income in taxes than lower income groups. The general concept seems to be that wealthier individuals can "afford" higher payments, that there are minimal essential costs and, with incomes above that level, individuals are indulging in fewer essential purchases. Progressive taxes then can be used to reallocate monies from higher to lower income groups. In countries without income taxes, the same effect can be achieved by taxing luxury products, like cars, and subsidizing food for the poor.

Fair Share: The notion of contributing one's "fair share" has a strong fairness component. One contributes what one can. The complexity arises in deciding who makes the judgment of what is appropriate. Is it the individual, a decision which can lead to broad disagreements, or is it in proportion to what one has, which reduces to the ability to pay? Moreover, the time period over which the contributions are made is another component. Should each event be independent, or is the share cumulative and long term? That is a little like calculating good nutrition. While a nutritionist would consider good nutrition to be a particular balance from the major food groups at each meal, many individuals understand it as a balance over multiple meals in a rather fluid time period. Returning to financial matters, does the calculation transcend generations so that those, for example, who give and receive compensation are not necessarily the perpetrators and victims? Should the current generation of US citizens compensate the descendants of wronged slaves even though that worst of all human abuses ceased more than six generations ago? Should the Japanese government compensate other governments whose peoples were victimized 50 years ago? Clearly, there are many dimensions over which the "fair share" can be determined, each based on some kind of value judgment, making broad agreement difficult to achieve.

Without Interpersonal Comparisons:

No Harm Done: One value-free perspective on equity is if, after the fact, all participants come out at least as well as they began, and there is not an injured or disadvantaged party. In economic theory terms, this is close to the concept of "Parieto Optimality" which says, in its simplest terms, the only unambiguous way to advance group (social) welfare is for some individuals to be made better off and none worse off. Thus a technical innovation which netted an individual $3 billion but left the rest of the world's population unchanged would be Parieto Optimal. So would an innovation which gave nearly everyone $1.00. Such a conclusion, it can be demonstrated theoretically, is equivalent to saying the underlying income distribution does not affect personal or social welfare.

An alternative, and slightly less restrictive approach, posits that welfare is enhanced if those benefited can compensate those who are disadvantaged. Examples are often given in monetary terms, although conceptually there is

no reason to limit the benefits and compensation to money. A simple example would include a change benefiting "A" by $100 but costing "B" $50; since A can compensate B and still be better off, social welfare has improved. Two specific points should be made in this regard. First, achieving this kind of equity does not require the compensatory payments actually be made. It is sufficient that enough benefits be generated to make possible the payments. Second, the assessment assumes income distribution does not matter, yet if A is wealthy and B poor, $50 may mean more to B than $100 does to A. Clearly on a governmental/societal level, there are severe limitations with this approach.

Marginal Conditions: The marginality approach is really a matter of efficiency; if all economic systems operate flawlessly then equity will be achieved. Efficiency requires efficiency in production so that nothing is wasted, efficiency in responding to users' requirements so there are no shortages and surpluses, and open exchange so that those with a surplus of an item can exchange with those in a deficit position. Open exchange is not limited to a nation, but implies free trade as well. For the economic theorist, as this is a theoretical economic argument related to concepts of perfect competition, the equity argument can be extended further. Under competitive conditions, prices are equal to their "worth" and workers are paid according to their contributions.

The marginalist approach then characterizes a tidy world within which equity is formally defined. It has clear limitations as well, with three in particular:

(a) measurement in practice is difficult,

(b) the income distribution is assumed not to affect welfare, and

(c) there must be no uncompensated pollution, no non-priced components in the economy.

While these conditions can never be fully met, the approach does have the distinct benefit of suggesting equity can be enhanced by moving to a more efficient and open economic system. For the value-based systems discussed above, no such value-free statement about increasing social welfare could be made.

5.2 Implications for Technology Transfer

Based on this brief overview, the difficulties countries have had discussing equity are not at all surprising. Chapman (1994), for example, discusses the difficulties with the implication at the International Covenant on Economic, Social and Cultural Rights. It is fully possible, indeed likely, that different national representatives are being completely sincere while discussing entirely different matters. This seems most likely when one group discusses equity from the perspective that interpersonal welfare comparisons cannot be made, while the other believes that is the only appropriate approach. What are the implications for technology transfer under the Convention?

Considering technology transfer narrowly as individual transactions, the commercialization of genetic resources, and the purchase of a biotechnology, there is a key benefit to the marginality approach. The benefit is that if the marginality conditions are met, transactions are simultaneously efficient and equitable, at least in a narrow perspective. The conditions for marginality however are, as noted, stringent:

(a) competitive economic system,

(b) no externalities, and

(c) reasonably uniform income distribution for all affected.

While income distribution is clearly a fundamental matter, not to be resolved here, it can be abstracted to a degree when considering only small, individual arrangements, those too insignificant to affect income distribution significantly. Externalities like pollution can be dealt with, at least in part, through conditions/requirements on agreements. Hence the remaining key condition for marginality is the maintenance of competition. This is something for national governments to strive for in general. In particular, regarding the Convention, effective competition between developing country sellers of genetic resources and developed country sellers of biotech products implies capacity building in negotiating and related activities for developing country representatives. Clearly the marginality approach will not resolve the major on-going issues regarding genetic resources, but it provides a clear, defensible basis on which to conduct individual transactions.

A competitive marketing system, as required by the marginality system, mandates a free (open) trading system as well as other internal conditions. That places an additional responsibility on national governments, in addition to commitments already made under the Uruguay Round of GATT. Indeed, the Convention requirement for technology transfer mandates "fair" as well as "most favorable" terms (Article 16(2)). "Most favorable terms" is close to the GATT requirement of Most-Favored-Nation

Treatment (MFN). MFN Treatment specifies that "any advantage, favor, privilege or immunity granted by any contracting party to . . . any other country shall be accorded immediately and unconditionally to . . . all other contracting parties." (Article I (1)). Hence, internationally as well as nationally, there is a need for nondiscrimination.

The broader issues are those which involve in a large measure matters of income distribution. When income distribution is included, the discussions move beyond the realm of the abstract into value judgments about what will enhance social welfare worldwide. The subject becomes one of ability to pay, or fair share; in short, a call for income transfer from the richer developed countries to the poorer developing ones. From that perspective, such issues as Farmers' Rights can be cast in terms of income distribution, Farmers' Rights being "rights arising from the past, present and future contributions of farmers in conserving, improving and making available plant genetic resources..." (see Section 5.3). Clearly one of the implications of this definition is that traditional farmers have done their fair share regarding agricultural germplasm and now are deserving of a reward. In this instance the users of these plant genetic resources, the plant breeders, also seem to feel they have made a contribution in the transformation of "unimproved" to "improved" germplasm. At a broader level, Agenda 21 in Principal 7 refers to developed countries acknowledging "the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command." These are true issues of equity which go beyond the scope of technology transfer as addressed in this paper.

5.3 Conclusions

Equity is a far reaching concept involving individual, cultural, religious, and national matters such that international agreement is nearly impossible to achieve. Changes can be determined only by comparing states of social welfare, but that requires value judgments. Equity systems termed "ability to pay" and "fair share" are based on such value judgments which, in terms of incomes, say that money is "worth" more to the poor than to the rich. Yet as intuitively appealing as that judgment may be, it lacks any substantive support, and becomes yet more complicated as events and time periods over which the adjustments are being made grow longer and longer.

For purposes here, a simpler, partial concept of equity is proposed. With this, known as marginality, it can be demonstrated that a form of equity results from a competitive market system with free trade. While remaining an ideal condition overall, the marginality concept provides a state for governments to strive for, including no uncompensated pollution. For technology transfer under the Convention, it emphasizes the importance of capacity training for developing country negotiators with multinational firms. Capacity building cannot assure balanced competition between those disparate parties, but competition certainly will not exist without skilled negotiators.

At a more fundamental level, the marginalist approach assumes income distributions, such as between developed and developing countries, does not matter for equity. Clearly that is a major limitation for seeking a position of true equity. But while limited, the marginalist approach does provide a value-free approach to follow to enhance equity in small, individual transactions which will have only limited effects on income distributions. The marginalist approach is recommended as a basis for technology transfer decisions until a broader consensus on equity emerges.

6. Conclusions

The fundamental conclusions can be stated quite succinctly as follows:

Role of Technology Transfer: Technology transfer is described in the Convention as a (one) means of achieving the objectives of both conservation and sustainable use, and equity, including the use of indigenous and traditional knowledge. Achieving all goals simultaneously through technology transfer will require very careful planning and consideration.

Institutional and Cooperative Technologies: Technologies can be categorized as institutional and cooperative, the latter category referring principally to knowledge generated communally by traditional societies. Conceptually there is no difference in these forms of technology; technology can be defined as applied knowledge with a problem-solving objective. Practically, however, these forms of technology are treated quite differently due to the level of description, development, and modifications required for additional uses.

Technology Transfer and IPR: IPR plays several critical (but not unsubstitutable) roles in technology transfer and is so identified in the Convention on Biological Diversity, particularly in Article 16. This explains the attention directed to IPR systems under the Convention, including in this document.

Traditional IPR: Traditional IPR consists, for the technologies relevant to the Convention, of patents, Plant Breeders' Rights, trademarks, and trade secrets. These systems have been shown to be efficacious in stimulating R&D investments and transfer of institutional technologies. Implications for technology transfer are more difficult to assess and should be studied in greater depth given their role under the Convention. Complicating the evaluation of the role of IPR on technology transfer is the availability of substitute control mechanisms, especially secrecy. These alternatives however have costs as well which need to be considered in comparison with the costs of IPR, largely royalties.

Geographical Extent of Traditional IPR: Many countries exclude patents for plants, animals, and pharmaceuticals, just those easily copied areas for which IPR protection is considered especially relevant. Commitments to enhance GATT's IPR protection (known as TRIPs) will not necessarily change that, but can be credited with the rapid adoption of Plant Breeders' Rights legislation in numerous developing countries.

Traditional IPR and Cooperative Inventions: Traditional IPR, while not specifically excluding it, is not well suited for the protection of cooperative inventions, largely because the degree of development and characterization do not meet the detailed requirements of patent and related legislation. The communal nature further eliminates much opportunity for the use of trade secrets. Moreover, other potentially relevant systems, including Farmers' Rights, protection for folklore, codes of conduct, and appellations of origin, among others, are not broadly applicable either, although they may suffice in certain limited cases. Hence real protection will require another form or forms of legislation.

"Fair Share": The discussion of IPR systems relates primarily to the efficacy of technology transfer, but implies nothing specific about its equity. Two major approaches to equity are explored; one based on judgments or value systems, the other on more technical considerations. Real equity can be achieved only in regards to value based systems, but it is extremely difficult to gain international agreement over their provisions. Hence for the limited perspectives of technology transfer, an alternative approach is proposed for the short term which is based on the kind of equity achievable through efficiency, competition, and free exchange. For the Convention that approach emphasizes the need for training developing country representatives in negotiating skills and related legal concepts.

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