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Faculté de Droit
Centre de Philosophie du Droit.

The Property Regime of Biodiversity and Traditional Knowledge

Institutions for Conservation and Innovation

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Dissertation présentée en vue de l'obtention du grade de docteur en droit

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*A mon père qui m'a donné le goût des affaires publiques
et à celle et ceux qui l'entretiennent tous les jours*

Qu'on ne dise pas que je n'ai rien dit de nouveau: la disposition des matières est nouvelle; quand on joue à la paume, c'est une même balle dont on joue l'un et l'autre, mais l'un la place mieux.

J'aimerais autant qu'on me dît que je me suis servi des mots anciens. Et comme si les mêmes pensées ne formaient pas un autre corps de discours, par une disposition différente, aussi bien que les mêmes mots forment d'autres pensées par leur différente disposition.

Blaise Pascal, *Pensées*

Acknowledgements

This thesis has been conducted at the Center for Philosophy of Law at the Catholic University of Louvain with a one year research stay in Yokohama, Japan at the United Nations University Institute of Advanced Studies. I wish to thank both of these organizations for their innovative approach to research and for providing me with the framework that allowed me to conduct this research.

I wish to thank my supervisor, Professor Jacques Lenoble for his constant ability to enter into my reasoning, to identify the intentions behind my clumsy prose and to help me clarify and further develop my personal reflection.

I am also grateful to Professor Tom Dedeurwaerdere, Professor Bernard Remiche, and Professor Philippe Coppens, as members of my supervision committee, for the time they spent reading and commenting on my PhD proposal and drafts of this dissertation. Their remarks helped me clarify several technical and methodological issues. I thank Professor Henri Simonart, Professor Geertrui Van Overwalle and Professor Jerome Reichman for accepting to join my jury. I look forward to receiving their comments.

I wish to offer an additional thank you to Professor Jerome Reichman as it is his work that gave me the inspiration for the comparative and theoretical approach adopted within this dissertation.

I heartily thank Sélim Louafi, Brendan Tobin and Carmen Richerzaghen for their restless encouragement, stimulating contestation and positive suggestions.

I am grateful to my friends and research colleagues for their engaging presence and countless discussions on the servitude and greatness of being PhD students: Vincent, Idesbald, François, Ivan, Lalaina, Noah, Laurence, Alain, Véronique, Anne, Christine and all the others.

One of the people who I am very indebted to is Heather Ritch who translated my inelegant prose into the English language.

Last, but certainly not least, I am grateful to Diane who against any logic never stopped being proud of having a PhD student as her husband.

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General Introduction

A. The Subject-matter

In this dissertation, I examine the property regime of genetic resources and traditional knowledge established by the Convention on Biological Diversity (CBD). I analyze how it ensures conservation of and access to genetic resources and traditional knowledge (TK) and how it feeds innovation in bio-industries today and tomorrow.

Notions of Biodiversity and Traditional Knowledge

According to the Convention on Biological Diversity, the expression “**biological diversity**” or “**biodiversity**” designates the variability among living organisms and the complex ecologies of which they are a part; this includes diversity within species (genetic diversity), between species and of ecosystems. In this dissertation, biodiversity is regarded at the level of genetic diversity. One important benefit provided by biodiversity, and the one of most interest in this dissertation, lies in its role as **input into the research and development process (R&D) of “bio-industries”** (e.g. pharmaceutical and agricultural industries). Bio-industries can be conceived of as defense systems or dynamic contests between human societies and nature. These industries consist of relentless efforts to struggle against the erosion of human erected defenses against a hostile biological world.¹ In agriculture, there is a perpetual renewal of the defense system that guards our food crops against constantly evolving pests and predators. Similarly, in medicine, there are efforts to defend human beings against direct aggressions. In both sectors, our defense efforts are perpetually eroding and must be constantly renewed.² The same forces that are operating against the human domain are also at work against other living organisms. Any life form that survives has developed resistances that are successful in a contested environment.³ It is for the retention of these existing resistance strategies that human societies need biodiversity. Unfortunately, while the development of biotechnologies increases the possibility of using biodiversity, biodiversity is **eroding**, most notably because human societies prefer to convert biodiversity intense land into more immediately profitable uses.

¹ Timothy M. Swanson (1996), “The Reliance of Northern Economies on Southern Biodiversity: Biodiversity as Information”, 17 *ECOLOGICAL ECONOMICS* 1, p. 2

² *Ibidem*, p. 13

³ *Ibidem*

As for **traditional knowledge**, the Convention on Biological Diversity uses this expression to designate “*innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity*”. Recently, traditional knowledge has also been acknowledged as an important **source of information** for modern science. Traditional knowledge is notably used to increase the probability of identifying resistance strategies. Unfortunately, at the precise moment where the contribution of TK to science is recognized, there is an important **erosion** of this knowledge. The main threats to traditional knowledge are the poor economic conditions of local and indigenous communities and the erosion of biodiversity. Because TK holders live in close connection with their environment and have developed knowledge specific to their immediate environment, they are among the first victims of their environmental degradation and TK is subject to the same threats as biodiversity.

Therefore, we have to cope with a **chain of innovation**, originating upstream with biodiversity (genetic resources) and sometimes traditional knowledge, and ending downstream with a final product (e.g. a new plant variety or a medicine)⁴. All elements of this chain of innovation have a common characteristic, they are knowledge goods.

Objectives of the Property Regime Created by the CBD

In view of both the usefulness and the erosion of biodiversity and traditional knowledge, their **property regimes must aim at one general purpose**: to ensure biotechnological innovations for today and tomorrow. This general purpose can be divided in **two objectives**: (1) downstream, favoring innovation and (2) upstream, ensuring the conservation of and access to the inputs of innovation, i.e. genetic resources and traditional knowledge.

In this dissertation, I focus mainly on the solutions that have been set up to achieve the second objective, (conservation of and access to the inputs of innovation)⁵, but I examine these solutions in light of the general objective (innovation today and tomorrow).

⁴ Often the chain of innovation is not continuous and linear; where there is a final product, such as a new plant variety or a medicine (downstream), biological resources are almost always found at the upstream end.

⁵ Actually, I also pay much attention to the first objective (favoring innovation) in the first part of this dissertation, though it is mainly as way to build an analytical framework that enables me to better understand how to ensure the second objective (*Cf. infra*).

Objectives of this Dissertation

The objectives of this dissertation consists of (i) identifying and describing the solutions that have been tested or discussed; (ii) examining to what extent these solutions fulfill the objectives mentioned above and therefore to identify their limits; (iii) attempting to explain the reasons of these limits, and (iv) to some extent suggesting elements of solution.

Tested and Discussed Solutions

The solution considered by the Convention on Biological Diversity consists of granting exclusive rights as an incentive to conserve biodiversity and traditional knowledge.

In intergovernmental discussions, governments have come to this solution by observing an asymmetry among countries. Schematically, most remaining biodiversity and associated traditional knowledge lies in tropical developing countries, while most technical capacities to use biodiversity to develop new products lies in industrialized countries. For a long time, genetic resources had been in open-access. When industrialized countries decided to grant intellectual property rights (IPRs) to “bio-inventions” or “worked genetic resources” in order to enable bio-industries to capture the benefits of their research and development, developing countries reacted by claiming national sovereignty over their “raw genetic resources”. Indeed, they did not want to continue to provide their “raw genetic resources” for free while they had to pay to obtain industrialized countries’ “worked genetic resources”.

Academic circles came to the same conclusion through theoretical reasoning. The theory of property rights developed by Ronald Coase⁶ predicts that problems of externalities and public goods can be solved by the creation of property rights when transaction costs are low. The conservation of biodiversity and traditional knowledge appears to be a public good or at least a source of positive externalities: biodiversity and traditional knowledge (TK) are not only useful for their holders but also for the international community because they are useful sources of information for bio-industry. If countries rich in biodiversity and TK holders cannot capture the benefits of conserving biodiversity and traditional knowledge, they will under-invest in conservation, and destroy biodiversity by turning land where it lies to more immediately productive

⁶ Ronald Coase (1960), “The Problem of Social Cost”, 3 JOURNAL OF LAW AND ECONOMICS 1

uses. One possible solution lies in the creation of property rights that enable holders of genetic resources and TK to internalize the benefits of conservation.

As a result, the Convention on Biological Diversity confirms the patentability of biotechnological innovations and invests states with national sovereignty over their genetic resources and to some extent invests local and indigenous communities with a property right to their traditional knowledge. In so doing, the Convention encourages the negotiation of bioprospecting contracts by which bio-industries could obtain access to genetic resources and knowledge from biodiverse countries and TK holders. In the situation where innovations were developed or derived from these genetic resources or traditional knowledge, the contracts would provide for the sharing of benefits. The potential for such compensation is supposed to encourage biodiverse countries and TK holders to conserve their biodiversity and knowledge.

Limits of These Solutions

To what extent do these solutions fulfill the objective to ensure the conservation of and access to the inputs of innovation, i.e. genetic resources and traditional knowledge?

Regarding genetic resources, the process of creating property rights is well-launched. The Convention grants states national sovereignty over their genetic resources and approximately fifty countries have enacted or have considered enacting legislation that regulates access to their genetic resources. Biodiverse countries and firms or research centers have signed a certain number of “bioprospecting contracts”. Even if it might be a bit early to assess the solution proposed by the Convention, observers already point to a series of problems. It seems that this mechanism seriously hinders bio-industries’ access to genetic resources. In addition, it turns out that the creation of property rights has not generated sufficient benefits to fund the conservation of biodiversity.

Concerning traditional knowledge, we are considering the same solutions, but the process of creating property rights is less advanced. The issue of protecting traditional knowledge has appeared more recently on the international scene on the initiative of a series of NGOs and representatives of indigenous peoples. NGOs and later academics have also suggested resorting to property rights to foster the conservation and use of traditional knowledge. The discussion has been launched in the organs of the Convention of Biological Diversity, the World Trade Organization and above all the World Intellectual Property

Organization. However, after a few years of discussion, no clear idea of the content of a property right to traditional knowledge has emerged.

B. A Comparative and Theoretical Approach

In order to contribute to this highly polarized debate, I have stepped back and examined whether the discussions on genetic resources and traditional knowledge are examples of broader phenomena that have already been observed and theorized.

As a result, I start from the observation that genetic resources and traditional knowledge are knowledge and I look at the branch of law that usually deals with the production of knowledge, i.e. intellectual property law, to build both a comparative and theoretical approach.

First, I believe it is useful to **compare** the discussions on the property regime for genetic resources and traditional knowledge protection with the ongoing transformation of the IPRs system. Many of the current analyses of the wild genetic resources property regime, as well as the current discussions on traditional knowledge protection tend to regard these two issues as marginal or novel and, therefore, they fail to see any similarity with the current IPR system. On the contrary, I do not believe that these two issues raised unprecedented questions for which a different system of protection should be invented. This comparison first reveals that the interrogations on the functioning of the IPRs system are indeed pretty much the same. A second contribution of this comparative approach consists of observing solutions that have already been tested in the IPRs system and could, as such, inspire similar solutions for genetic resources and TK. For these reasons, I have written the three parts of the dissertation like three parallel histories. This enables me to point out striking analogies between the evolution of the intellectual property system, the evolution of the genetic resources property regime and the discussions on traditional knowledge protection.

Second, if a close examination of the legal texts is necessary, it is not sufficient to reach the goals of this dissertation. Therefore, I need to rely on some **theory** to explain the evolution of the law and provide an assessment. Among the different theories of governance, I chose to draw on the law & economics literature (or economic analysis of law) because this literature guided the drafting the Convention on Biological Diversity and is still used in the search for efficient mechanisms to conserve and use biodiversity. Law and economics is also the dominant theory used to

explain and assess the functioning of intellectual property law. Due to the fact that the law and economics of intellectual property are much more complex and developed, its insights are worthwhile in an analysis of genetic resource and traditional knowledge property regimes. The characteristic of law & economics consists of using economics both to explain the evolution of the law and to suggest solutions. In this dissertation, the economic analysis of law is helpful in its normative as well as its positive aspects. The positive economic analysis of law consists of attempting to explain legal rules as they are. Even if the intellectual property system and the property regimes of genetic resources and traditional knowledge are largely the result of historical accretion developed without much scientific basis, I believe that an economic analysis of these regimes can provide some rationalization for how they function and some assessment of their achievements⁷. The normative role of economic analysis of law designates the possibility of providing an assessment of the law and to make recommendations for change. The economist is not able to tell society what goals it should set but the economist may be able to show whether or not the means by which a society attempt to reach these goals are effective.

This comparative and theoretical approach enables me to reconsider biological resources and traditional knowledge protection as emblematic issues, rather than specific and marginal issues of the current IPR system. This approach provides me with an analytical framework to give an account and assessment of the evolution of the biological resources property regime with regards to the objectives of the Convention on Biological Diversity. Furthermore, using this approach permits me to evaluate alternative proposals for protecting traditional knowledge.

C. Contribution of this Approach

Explanations of the Current Difficulties

In general, I believe that this comparative and theoretical approach contributes to achieving clarity on an otherwise confusing topic. More precisely, this approach enables me to identify explanations for the difficulties involved in the progress on the discussions regarding genetic resources and traditional knowledge. It seems to me that these difficulties can be explained notably by (1) an illusion, and (2) an implicit methodological choice in the design of property rights.

⁷ However, going through the law and economics literature on intellectual property reveals that many questions remain open, making the topic both interesting and lively.

Discussions on the protection of genetic resources and traditional knowledge are based on the illusion that once the state (the law) has created property rights, the market alone will ensure an automatic and efficient coordination of the exchange of rights to genetic resources and traditional knowledge.

Attempts to create property rights to genetic resources, and above all traditional knowledge, usually resort to justifications in terms of moral rights, natural rights or human rights⁸. Although, those justifications have an important rhetorical power, they offer little guidance on the design of well-defined and enforceable property rights. The difficulty is that those justifications do not take into account the characteristics of genetic resources and traditional knowledge, their usefulness and their condition of use; also, they do not pay attention to the effect of the creation of property rights.

Change of Perspective

In contrast, in accordance with the approach described here, I observe that the market alone cannot always ensure the perfect coordination of exchanges of rights to genetic resources and traditional knowledge. More complex mechanisms of coordination, including state intervention or forms of self-regulation by economic agents, or a combination of both, prove to be necessary. An additional characteristic of these forms of self-regulation is that they create some forms of intermediary property regimes (common property) in addition to the two classical extremes: individual property and open-access.

Regarding the design of property rights, I suggest using a utilitarian or economic approach⁹ to design property rights. This approach, which is the dominant justification for intellectual property rights, is not extensively used for designing property rights to genetic resources and is totally absent in the discussions on traditional knowledge¹⁰. The contribution of economics enables me to take into account the characteristics of genetic resources and traditional knowledge, their

⁸ These justifications are sometimes collectively designated as “rights-based” justifications or “backward looking” justifications.

⁹ This type of justification is sometimes also designated a “consequentialist” justification or “forward looking” justification.

¹⁰ For an interesting exception see Padmashree Gehl Sampath (2005), *Regulating Bioprospecting: Institutions for Drug-research, Access and Benefit Sharing*, Tokyo: United Nations University Press.

usefulness, the conditions in which they are used and the effect of the creation of property rights.

D. Future Developments

This dissertation, like all research, is not a terminal process but rather a call for further research. Therefore it might be worthwhile to indicate where this dissertation stops and where further research may continue.

I believe the economic theory of intellectual property has made much progress by placing the coordination of knowledge and IPRs exchanges at the center of its research agenda and by integrating the lessons of the entitlement literature and new institutional economics. In parallel with this theoretical evolution, I have described examples of self-regulation¹¹. I stopped my research at the same stage as IPR theory and the practical cases. However, a number of issues remain poorly understood. Intellectual property theory still needs to suggest solutions for situations where collective rights organizations or other forms of self-regulation would otherwise be efficient but simply do not emerge. In other words, we must still strive to understand when and how government (law) can facilitate the emergence of these collective rights organizations. Another unresolved issue concerns negative externalities, i.e. whether collective rights organizations or other forms of self-regulation, which are efficient for the members of particular social groups, are also efficient for society as a whole.

Future works could include the identification and documentation of practical examples of a more complex mix of self-regulation and government intervention (law). Future works could also include explorations into the lessons of the theoretical literature on regulation, self-regulation and forms of “co-regulation” and their integration into intellectual property scholarship.

¹¹ In this dissertation, self-regulation designates forms of coordination defined by the following elements: (1) some degree of collective constraint, (2) other than that directly emanating from government, (3) to engender outcomes which would not be reached by individual market behavior alone. See Julia Black (1996) “Constitutionalising Self-Regulation”, 59 MODERN LAW REVIEW, 24-55

Part One:
An History of the Evolution
of the System of Intellectual Property
and its Economic Theorization

Introduction

The objective of the first part of this dissertation is to provide the analytical framework necessary to characterize biological resources and traditional knowledge as part of a property regime. In doing so, I have gathered the work of several scholars in order to present an historical account of the evolution of the system of intellectual property, to identify the economic rationale for the creation of rights to knowledge, to feature the engines of changes in intellectual property law, and to present the unanticipated problems and current attempts made to create solutions to the existing dilemmas. In parallel, I attempt to show that these developments and unexpected difficulties have led to a theoretical evolution by scholars to integrate useful elements of existing theories into the law and economics of intellectual property.

This historical and theoretical reconstruction can briefly be summarized as follows. In the first chapter, I present the simple economics of intellectual property that have long been regarded as sufficient to justify intellectual property rights (IPRs). As we will see below, this “simple economics” explains only some aspects of IPRs, yet much of the writing on patent law refers solely to this model. According to this “simple economics”, IPRs are incentives to innovate, i.e. to produce new knowledge. The creation of IPRs and their characteristics are related to the nature of the good on which they apply –knowledge –, which requires the search for delicate balances. Indeed, knowledge is a non-exclusive good which renders it difficult for the producer to prevent third parties from using it, and in turn from appropriating the fruit of his investment. The creation of IPRs can be explained by the need to provide to knowledge producers with a means to exclude third parties and to fix a price to access the knowledge. Nevertheless, knowledge is also a non-rival good, which implies that it should be freely accessible to all. These properties of knowledge create a dilemma: only the ability to generate a profit motivates inventors to invest in the production of knowledge--however only free access can assure the efficient use of knowledge.

To overcome this dilemma, governments resort to two second-best solutions. In the first system, temporary exclusive rights (IPRs) to new knowledge are granted to enable the inventor to fix a price for its use. In the second system, society is responsible for covering the production costs of knowledge. In exchange of public subsidy, knowledge producers are denied exclusive rights.

In the second chapter, I describe how intellectual property law and to some extent social norms have originally set a two-part balance. Firstly, they draw a distinction between knowledge production that is best provided by the market and IPRs (generally applied research, downstream of the innovation chain) and knowledge production that is best provided through public funding and placed in open access regime (usually basic research, upstream of the innovation chain). Secondly, within each mode of knowledge production, intellectual property law and social norms attempt to identify the right level of protection so that incentives to produce and share knowledge can be combined in the most efficient way.

In chapter three, I examine how this two-part balance has been modified and I hypothesize that changes in intellectual property law can be explained by changes in innovation policy and in the innovative process.

In chapter four I observe that the evolution of intellectual property law has not been perfectly efficient. I identify unexpected problems such as the importance of IPR transferability in the context of collective and cumulative innovation, as well as the role of social norms and other forms of self-regulation in shaping knowledge exchanges. I then explain how intellectual property scholarship will try to cope with these new issues by integrating several bodies of existing theories into intellectual property theory.

To overcome these unexpected difficulties, two solutions are considered. First in chapter five, I examine the entitlement literature, which suggests that government can reduce transaction costs by modifying the entitlements of inventors and move from property rules to a liability rule or compulsory licensing regime. Finally, in chapter six, I observe the creation of collective rights organizations that facilitate transactions among holders of IPRs and/or create some form of common property or limited space within which knowledge is shared. This second solution is analyzed in light of “new institutional economics” (NIE) and to some extent in light of the “law and norms” literature initiated by Robert Ellickson.

1. Property Rights to Knowledge

In this first chapter, I present the economics of intellectual property rights (IPRs) that have long been regarded as the basic justifications for granting rights over intangibles. The economics of IPRs can be seen as attempt to transpose the lessons from the economics of tangible property to intangible property. Traditionally, the economics of intellectual property have been limited to the identification of two functions of property rights, (i) the role of coordination, and (ii) the role of incentive, and their effect on the production and use of a specific good, i.e. knowledge.

1.1 Property Rights...

From a legal perspective, property is a bundle of rights that describes what the owner may do with the goods he owns, i.e. the extent to which he may possess, use, develop, transform, rent, sell, mortgage, exclude access to others from their owning, etc. The owner is free to exercise his rights while others are forbidden to interfere with the exercise of his rights.¹² In other words, property provides the possibility to use a good, to exclude others from using a good, and to transfer a good. While the law of property supplies the legal framework for allocating resources and distributing wealth, an economic theory of property tries to predict the effects of alternative forms of ownership on efficiency and distribution of resources. In this dissertation, I will focus on how alternative bundles of rights to knowledge (IPRs) create incentives to use resources efficiently.

Economists draw a distinction between static and dynamic analysis, and so they distinguish static and dynamic benefit of property rights. **The static benefit** of property rights is best explained by example. Imagine an open-access pasture; that is, no one has the right to exclude others and hence no one can charge a price for the use of the pasture. Each farmer has to decide how many cows he will bring to the pasture. Pasturing an additional cow reduces the quantity of grass and hence imposes a cost on all the farmers. This is because each cow will have to graze more in order to eat the same quantity of grass, and in doing so their weight will be reduced. Since none of the farmers pay for the use of

¹² Economists have a larger definition of property in the sense that economic property rights include not only legal property rights but also other forms of control that produce the same effects of creating some degree of exclusiveness and transferability. See Yoram Barzel (1997), *The Economic Analysis of Property Rights*, Cambridge University Press, 2nd ed., p. 3

the pasture, they are unlikely to take this cost into account, with the result that more cows will be pastured than would be efficient. This loss, called **deadweight loss**¹³, can be solved if one farmer owns the pasture and charges the other farmers for their use of his pasture. The charge to the farmer will include the cost he imposes on other farmers because as extra cows diminish the value of accessing the pasture, the charge farmers are ready to pay to access the pasture is also reduced.¹⁴ Thus, a property right is a kind of coordination mechanism that solves the problem of **collective action**. The main alternative to property rights is the regulatory power of the state, and in some circumstances customs or social norms.

The dynamic benefit of property rights concerns investment. This can also be illustrated using the example of the pasture. A farmer may estimate that it would be more profitable for him to decide to use his pasture as a wheat field rather than grazing for cattle. The farmer will plow the field, plant wheat and fertilize. In the absence of a property right, when the wheat is ripe, the farmer may find his neighbors reaping the wheat and have no remedy to stop them from doing so. If this should happen, the farmer is likely to abandon his activity and move to other activities that require less investment. Where the farmer is able to exclude others from reaping the wheat he has sown, property rights create an incentive for him to invest in the creation or improvement of a resource in period one, as no one else can appropriate the resource in period two. It enables the farmer/owner to collect the fruit of his investment. Without this prospect, people would have little or no incentive to invest. This dynamic benefit of property rights is the main economic reason to create intellectual property rights.¹⁵

1.2 ... to Knowledge

Intellectual property rights constitute a special category of property rights that are applied to knowledge-related activities. These rights do

¹³ An individual self-interested opportunistic act creates deadweight loss whenever the costs it inflicts on others exceed the individual's benefit from the act. Negative externalities do not necessarily give rise to deadweight loss because the externality may provide more benefits to its author than costs to affected parties.

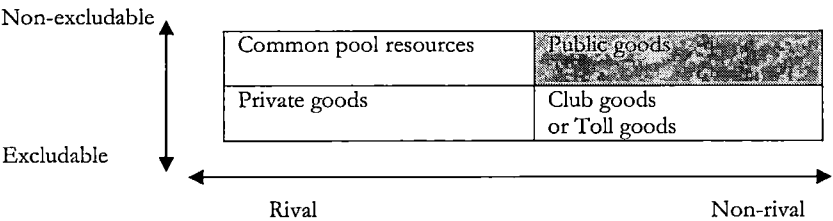
¹⁴ William M. Landes & Richard A. Posner (2003), *The Economic Structure of Intellectual Property Law*, The Belknap Press of Harvard University Press, Cambridge, Massachusetts and London, England, p. 12, hereafter Landes and Posner (2003) *The Economic Structure of IP Law* (...)

¹⁵ *Ibidem*, p. 13

not apply to the physical object in which the intellectual creation (knowledge) may be embodied but rather to intellectual creations as such. In other words, intellectual property rights apply to pieces of knowledge or information¹⁶ that belong to a special category of goods called “public goods”. Accordingly, the economic theory of intellectual property rights must be customized to take into account public goods characteristics.

1.2.1 Knowledge and Public Goods

According to the economist, knowledge is a particular type of good with properties that differ from ordinary (or private) goods, and therefore justify an adapted legal regime. These properties are ambivalent. On one hand, knowledge production activities have a high social benefit that makes it an important factor of growth; on the other hand, there are characteristics of knowledge that pose difficult problems of resource allocation and coordination.¹⁷



Knowledge is a non-excludable good. It is difficult and extremely costly to render this good exclusive, or to control its access. This characteristic causes important externalities: knowledge benefits third parties without compensation. In addition, **knowledge is a non-rival good**¹⁸. As a resource, it is inexhaustible. This non-rivalry includes two dimensions. First, knowledge can be used repeatedly without additional cost. Second, an endless number of people can use knowledge simultaneously without depriving anyone else from using it. This property of non-rivalry has an important consequence on the fixation of

¹⁶ In the context of this dissertation, when considered as goods, information and knowledge are used interchangeably.

¹⁷ Dominique Foray (2000), *L'économie de la connaissance*, La Découverte, coll. Repères n°302, Paris, pp 59-66, hereafter Dominique Foray (2000), *L'économie de la connaissance*

¹⁸ This characteristic is also referred as non-rivalrous consumption or non-subtractability

costs and prices. Efficiency requires a price equal to marginal cost. However, non-rivalry implies a zero marginal cost, which forbids the use of marginal cost as criteria to fix prices. Without property rights, the use of knowledge would be free¹⁹ and it would become impossible to compensate production costs.

Finally, **knowledge is a cumulative good**. In science and technology, knowledge is cumulative and progressive. Knowledge is the principal source or input for the production of new knowledge. This means that a non-rival good is not only an output (a poem, a piece of music, etc) but is also potentially an input likely to be used an endless number of times in the production of new knowledge.

The importance of the social benefit (externalities) of the R&D activities has its origins in the above three properties of knowledge.

1.2.2 The Problem of Public Goods: What Can Be Privately Owned?

When knowledge production generates a profit, the appropriation of its entire value is nearly impossible because it is difficult to fully control knowledge (non-excludable good). Part of the profits are externalized, or in other words, captured by others. Where externalities exist, the inventor must anticipate that he will receive less than the social benefit of his invention. Insufficient levels of private investment are made where there is a lack of incentive to innovate in the first place. This problem of underinvestment is underscored by **free riding**. Free riders are actors who take more than their fair share of the benefits or do not shoulder their fair share of the costs of their use of a resource, involvement in a project, etc. If an inventor asks contribution to provide a new product that may benefit society, individuals expecting to benefit from it for free—they cannot be excluded—will be reluctant to pay for the invention. Public goods are important examples of market failure (or on other words a problem of collective action) in which market-like behavior of individual gain seeking does not produce efficient results. The fact that knowledge is a public good implies that the market alone cannot provide for its production in an efficient way.

There exists different types of interventions to provide for the efficient production of knowledge— but they are all confronted with the same **dilemma**. If one sees the issue from the utilization viewpoint, there is

¹⁹ Apart from the cost of transmitting knowledge

zero marginal cost; consequently, for maximum efficiency, there should be no restriction on the use of knowledge and it should be available at zero cost to users. Knowledge should be a “free good”, as this is the optimal condition of use for a non-rival good. The issue appears differently from the production viewpoint. Producing knowledge is costly; maximum efficiency in production implies that all production costs are covered by the economic value of the created knowledge. This assumes that producers can appropriate the benefits of knowledge by restricting access and charging a positive price controlling access. **The knowledge dilemma** can be summed up as such: only with the expectation of being able to charge a users fee will producers of knowledge invest in its production;; only where no cost to users exists can the efficient use of knowledge be assured. . This dilemma is reinforced by the cumulative characteristic of knowledge that makes it both an output and an input.²⁰

There are two principal incentive and coordination mechanisms²¹ that tackle the issues of knowledge externalities. The first system, which will be referred to as “Technology”²², remedies the public good problem by increasing the degree of appropriability.²³ Temporary exclusive rights (IPRs) to the new knowledge are granted, which enables the inventor to fix a price for their use²⁴. Thus, the problem of collective action caused by free riding is tackled by the creation of property rights that enable a partial internalization of knowledge externalities. In this system, which is employed for the majority of private enterprise R&D, the gain in dynamic efficiency, as a result of the greater innovative activity, is intended to balance out the losses from static inefficiency, i.e. the under-utilization of the knowledge or the under production of the goods protected by IPRs.

²⁰ Dominique Foray (2000), *L'économie de la connaissance*, p. 66

²¹ To a lesser extent public goods can also be produced by privilege or close-knit groups; and non-individualism can sometimes overcome the free-riding problem (*Cf. infra*)

²² Partha Dasgupta & Paul A. David (1994), “Toward a New Economics of Science”,
²³ RESEARCH POLICY 487, hereafter Partha Dasgupta & Paul A. David (1994), “Toward a New Economics of Science”

²³ The idea of solving problems of externalities and public good by the creation of property rights is generally attributed to Ronald Coase in Ronald Coase (1960) “The Problem of Social Cost” 3 JOURNAL OF LAW AND ECONOMICS 1.

²⁴ Note however, that IPRs are not the only way to appropriate the benefit of an invention, secret and technical advances play also an important role. To some extent, it can be said that the main function of IPRs and secret is to provide lead time to the knowledge producer (*Cf. chapter 2*)

In the second system, referred to as “Science”, society is responsible for covering the production costs of knowledge, as private initiative is substituted for public initiative. In this second system, two variants may exist. In the first variant, government engages directly in the production of knowledge, finances the production costs from general taxation, and allows the free use of its outputs.²⁵ The second possible variant occurs where society encourages the private production of knowledge by offering public subsidies for its production and relying upon general taxation to finance these subsidies. In exchange for being the recipients of public subsidies, producers are denied exclusive rights to the output of their R&D activities.²⁶ Thus, in both variants of this second system, the knowledge producer has no exclusive rights; the knowledge produced belongs to the whole society. In this light, a general norm of rapid communication and knowledge sharing predominates, thus enabling the constitution of cooperation networks. In this scenario, moving from unsuccessful voluntary provision to involuntary provision of the public good solves the collective action problem: the state imposes a tax on citizens to fund the provision of the public goods.

Thus, the distinction between Science and Technology refers to two sets of socio-political arrangements and their respective reward mechanisms affecting the allocation of resources for scientific research. What are considered legitimate goals, reward systems, and the norms of the disclosure of knowledge are distinct as between Science and Technologies.²⁷ The goal assigned to the community of Science is to increase the stock of public knowledge, whereas the objective of Technology is to increase the stream of rents that may be derived from possession of rights to use private knowledge. Each system has its own internal coherence. The two systems have contradictory norms that create some tensions at their boundaries but they are not mutually exclusive. Rather, it is argued that to ensure an efficient allocation of resources for the production of knowledge both systems and the maintenance of a synergetic equilibrium are required.²⁸

Each system has its comparative advantages and disadvantages. One evident advantage of Open-Science (public procurement) consists in

²⁵ This was at the heart of Samuelson’s analysis of the efficient production of public goods, Samuelson (1954), “The Pure Theory of Public Expenditure”, 36 *REVIEW OF ECONOMICS AND STATISTICS* November 387-389.

²⁶ Partha Dasgupta & Paul A. David (1994), “Toward a New Economics of Science”, p. 496

²⁷ *Ibidem*, p. 495

²⁸ *Ibidem*, p. 498

placing innovations in open-access regimes which enables the enjoyment of the non-rivalrous nature of knowledge. However, this advantage must be compared with possible principal-agent problems. Indeed, some characteristics of research activities, such as the great specialization of researchers, the elements of chance in the process of discovery, make it very costly and difficult for the funding government (the principal) to monitor scientists' works (agent) and to allocate funds between different research projects.²⁹ Conversely, the advantage of IPRs is that the market indicates the value of the innovation. Many inventors can obtain a patent but only inventions that are valuable to the market produce profits and income to inventors. IPRs, however, restrict access to non-rival goods and lead to smaller quantities of a good being produced at a higher cost than would be efficient.

Consequently, the knowledge dilemma requires the research of a double balance. First, a balance is required between research entrusted to Science (open research) and research entrusted to Technology (market and IPRs). The second balance must exist within each type of research (especially technology): the right level of protection must be found so that incentives to produce and share knowledge are combined in the most efficient way. Chapter two of this dissertation describes how this double balance was originally set.

²⁹ The Principal-Agent problem may also occur between the citizens and the government because it is very difficult for citizens to monitor how the state allocates funds for research.

2. A First Equilibrium: a Two-Part Balance

In this chapter, I describe two balances: one in the distribution of research activities between Technology (IPRs and the market) and Science (public funding and open access) and a second in the combination of incentives to produce and share knowledge within both Technology and Science. For the sake of clarity, I start with Technology and the definition of property rights to knowledge (section 2.1). Afterwards, I examine the distribution of research activities between Science and Technology and how knowledge is exchanged within Science (section 2.2).

2.1 Inside Technology: Definition of Property Rights to Knowledge

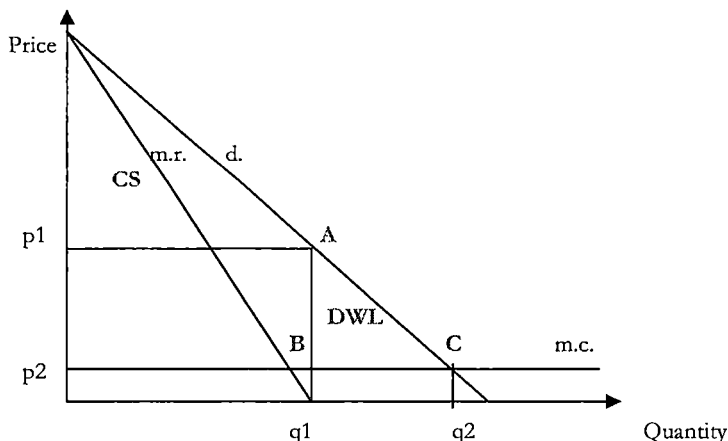
In analyzing the definition of IPRs inside Technology, I offer an initial examination of how the issue is conceived from an economics perspective, and then turn to consider how it is handled from a legal point of view.

2.1.1 The Economic Question: Balancing Dynamic Efficiency (incentive) and Static Efficiency (access)

As mentioned before, the public goods characteristic of knowledge complicates the definition of efficient property rights. On principle, (static) efficiency requires that price equals marginal cost. However, this is not possible for knowledge goods because it would give a negative profit to the knowledge producer. Indeed, knowledge creation is characterized by increasing returns, i.e. high fix costs and low (or zero) marginal cost. Fixing a price at marginal cost would not allow the producer to recover its fixed costs and generate a profit. IPRs are introduced for the precise reason that they enable the producer to fix a price higher than marginal cost. This solution, unfortunately, is not totally efficient. When price is above marginal cost, as permitted by IPRs, deadweight loss results: people who would have been willing to access the knowledge good at marginal cost are prevented from doing so due to a higher price set by the IPR holder, which they cannot afford.

The problem of deadweight loss is illustrated by the following: On the horizontal axis, all potential users are arranged by their willingness to pay. If the patent or copyright holder charges a single price (p_1), then all

the potential users to the left, for whom the willingness to pay is higher than the price, will buy the knowledge good. Each is getting some surplus (CS) because each is willing to pay more than the price. The users on the right are excluded, including those that are willing to pay more than marginal cost (m.c. or p_2) but less than p_1 . That is precisely deadweight loss (triangle ABC), the main social cost of IPRS.³⁰



In the absence of perfect solution, the role of the economic analysis of intellectual property has primarily consisted in cost-benefit analysis that approximates the best trade-off between access (static efficiency) and incentives (dynamic efficiency). In other words, economic analysis has attempted to identify whether and when the granting of intellectual property rights is justified. Similarly, the economic function of intellectual property law is to minimize the deadweight loss caused by IPRS: the conditions required for obtaining IPRS and the limited duration of these rights are legal instruments to approximate the best trade-off.

2.1.2 The Legal Answer: Patent requirements

In its early stage, intellectual property law consisted of two dominant systems of protection³¹: the patent system that grants a relatively short

³⁰ Adapted from N. Gallini and S. Scotchmer (2002), "Intellectual Property: When is it the best incentive system", in A. Jaffe, J. Lerner and S. Stern (eds.) *Innovation, Policy and the Economy*, Vol. 2, MIT Press, Massachusetts.

³¹ In this text, what I explain about IPRS only concerns patent, copyright and similar rights that confer a temporary exclusive right. Consequently, I am not concerned with

period of strong protection to useful, novel and inventive (non-obvious) inventions, and the copyright system that gives a relatively long and weak protection against copying for original and creative works.³² In addition, trade secret laws create an intermediary zone between formal IPRs and free competition. Trade secrets laws do not confer exclusive property rights but they require would-be competitors to extract an inventor's undisclosed know-how by "proper means". That is to say that would-be competitors have only three options: (1) to reverse engineer the technology from existing prototypes, (2) to create the product independently from scratch or (3) to acquire the unpatented know-how through licensing agreements with innovators. The main contribution of trade secret laws is to provide small-scale innovators sufficient lead-time to recover their R&D costs before their competitors enter the market.³³

In the case of patent law,³⁴ the World Trade Organization's (WTO) Agreement on Trade Related aspects of Intellectual Property (TRIPs), and the European Patent Convention (EPC) both provide that in order to obtain a patent, the applicant must demonstrate that his research results consist of an invention that is capable of industrial application, is

trademark or geographical indications. Although trademarks and geographical indications are legally a part of intellectual property law, the economist does not perceive them as serving the same economic function as patents and copyrights. According to economists, trademarks and geographical indications are primarily used to indicate the quality of goods and services to the consumer. See William M. Landes & Richard A. Posner (2003), *The Economic Structure of Intellectual Property Law*, chapter 7 "The Economics of Trademark Law" or a precedent article William M. Landes & Richard A. Posner (1987), "Trademark Law: an Economic Perspective", 30 JOURNAL OF LAW AND ECONOMICS 265

³² Jerome H. Reichman (2003), "Saving the Patent Law from Itself: Informal Remarks Concerning the Systemic Problems Afflicting Developed Intellectual Property Regime" in F. Scott Kieff (ed.), *Perspectives on Properties of the Human Genome Project*, Elsevier Academic Press, p. 293, hereafter Jerome H. Reichman (2003), "Saving the Patent Law from Itself..."

³³ See Jerome H. Reichman (1994), "Legal Hybrids between the Patent and Copyright Paradigms", 94 COLUM. L. REV. 2432, hereafter Jerome H. Reichman (1994), "Legal Hybrids..."

³⁴ Similar reasoning exists for copyright about the idea-expression dichotomy and the function of the originality requirement. See e.g. Landes & Posner (2003), *The Economic structure of IP law (...)*, or Jerome H. Reichman (1994), "Legal Hybrids..." or Jerome H. Reichman and Paul F. Uhler (2003), "A Contractually Reconstructed Research Commons for Scientific Data in a highly protectionist intellectual property environment", 66 LAW AND CONTEMPORARY PROBLEMS 315 hereafter Jerome H. Reichman and Paul F. Uhler (2003), "A Contractually Reconstructed Research Commons..." , or Paul A. David, "A tragedy of the Public Knowledge 'Commons'? Global Science, Intellectual Property and the Digital Technological Boomerang", MERIT Infonomics Research Memorandum Series

novel and involves an inventive step.³⁵ In the United States Patent Act, the conditions are roughly equivalent, even if they are phrased in a different terminology: the invention must be useful, novel and non-obvious.³⁶

The function of these requirements for patentability is to identify intellectual achievement for which the benefits of the incentive effect (a temporary right to exclude others from practicing the invention) will exceed the costs (society is prevented from practicing the invention and using it as input to future discoveries without permission from the inventor).

The most basic limitation on access to the patent system is that one may only patent something that is new. If this were not the case, the patent system would effectively restrict access to protected technologies (deadweight loss) without the countervailing benefits of increasing existing knowledge and promoting the development of welfare-enhancing technologies.³⁷

The distinction between an invention and a discovery, the requirement of industrial applicability in European patent law, and the role of the utility requirement in American patent law all play a major role in drawing the boundary between basic research and applied research. I will turn to discuss their role in the next section of this dissertation, which is devoted to the articulation between public science and IPRs protected R&D.

The inventive step or non-obviousness requirement is the most important criteria in identifying those inventions for which the benefits of the incentive effects of a property right exceed the costs of their underuse.

According to Article 56 of the EPC, an invention contains an inventive step if, having regard to the state of the art, it is not obvious to a person skilled in the art. To decide whether an inventive step is present, the

³⁵ European Patent Convention (EPC) article 52(1), Trade Related Aspects of Intellectual Property Agreement (TRIPs) of the World Trade Organization (WTO), article 27

³⁶ A footnote in the article 27 of the TRIPS Agreement regards the American and European terminology as equivalent.

³⁷ I do not dwell here on the definition of prior art and the difference between European and American law. I will come to that point when I tackle traditional knowledge in the third part of this dissertation.

European Patent Office (EPO) almost always applies the "problem-solution approach". The approach consists in: (1) identifying the closest prior art; (2) determining the objective technical problem, i.e. determining, in the view of the closest prior art, the technical problem which the claimed invention addresses and successfully solves; and (3) examining whether or not the claimed solution to the objective technical problem is obvious for the skilled person in view of the state of the art in general.³⁸ Inventions with minor improvements from the state of the art are often submitted for patentability. . This is common, for instance, when a new material is discovered; loads of patent claims are likely to surge for the making of well-known objects from the new material. The patent system requires the presence of an inventive step in order to exclude these claims from patentability.³⁹

In the American patent system, the non-obviousness standard plays a similar role. The history of American patent law reveals that both Congress and the Courts were very aware of the function of this requirement. The first Patent Act enacted in 1790 included only two requirements: novelty and utility.⁴⁰ However, it was quickly acknowledged that patents ought not to be granted for trivial advances. In 1851, the Supreme Court introduced the doctrine of invention as a third requirement for patentability. The Court distinguished minor improvements reflecting "*the work of the skilful mechanic*", which does not deserve patent protection, from substantial improvements reflecting "[*the work*] of the inventor".⁴¹ For the next hundreds years, the Courts struggled to quantify the advance necessary to qualify as an invention or as an inventive work. Despite a series of Supreme Court decisions⁴² refining the doctrine, much legal uncertainty remained regarding its exact content.⁴³ In 1952, Congress formally incorporated this third requirement and attempted to clarify its content into Section 103 of the

³⁸ The "problem-solution approach" was first developed by the EPO in decision T 24/81 EPO O.J. 1983, 133

³⁹ William Cornish & David Llewellyn (2003), *Intellectual Property: Patents, Copyrights, Trade Marks and Allied Rights*, Thomson Sweet & Maxwell, Fifth Edition, London, p. 191-192, hereafter William Cornish & David Llewellyn (2003), *Intellectual Property* (...)

⁴⁰ Patent Act of 1790, § 1, 1 Stat. 109

⁴¹ *Hotchkiss v. Greenwood*, 52 U.S. (11 How.) 248 (1851), at 267

⁴² See *Rubber-Tip Pencl Company v. Howard* 87 U.S (20 Wall.) 498 (1874); *Cuno Engineering Corp. v. Automatic devices Corp.* 314 U.S. 84 (1941); *Great A. & P. Tea Co. v. Supermarket Equip. Corp.* 340 U.S. 147 (1950)

⁴³ See for instance *Harries v. Air King Prods.*, 183 F.2d 158(2d Cir. 1950) where Judge Learned Hand complained the concept of invention was "as fugitive, impalpable, wayward, and vague a phantom as exists in the whole paraphernalia of legal concepts." (at. 162)

patent statute.⁴⁴ Section 103 describes the necessary advance in terms of whether the claimed subject matter “*would have been obvious at the time the invention was made to a person having ordinary skill in the art*”, rather than in terms of whether the advance constituted an “invention” or the work of an “inventor”.

Changing the name of the requirement from “inventions” to “nonobviousness” did not put an end to the legal uncertainty. There has been much discussion on whether the enactment of Section 103 was intended to lower the requirement or was merely a codification of judicial precedent.⁴⁵ In *Graham v. John Deere Co.*, the Supreme Court interpreted that Congress had not intended to lower the prerequisite of patentability.⁴⁶ Accordingly, the court opined that obviousness is to be determined against (1) a background of the prior art, (2) the differences between the claimed subject matter and the prior art, and (3) the ordinary level of skill in the art. The court also added that secondary considerations such as commercial success, long felt but unsolved needs, and failure of others, may have relevancy as indicia of nonobviousness. In addition, the Court explicitly affirmed the economic rationale of patent requirements providing that patent should be reserved for “those inventions which would not be disclosed or devised but for the inducement of a patent”.⁴⁷ For obvious or small-scale innovations the social cost of granting a patent is presumed to exceed the benefits of its incentive effect.

Last, the limited duration of patent and the disclosure obligations can also be analyzed as an attempt to find the best trade off between access and incitement.

This classical description of patent law fits well into what Merges and Nelson call the “discrete innovation model”. *It assumes that an invention is discrete and well defined, and is created through the inventor's insight and hard work.* Two features characterize this type of invention one of which has to do

⁴⁴ 35 U.S.C. § 103

⁴⁵ See e.g. Giles S. Rich (1963), “Congressional Intent – Or, Who Wrote the Patent Act of 1952”, in *Patent Procurement and Exploitation* reprinted in John F. Witherspoon (ed.) (1980) *Nonobviousness – The Ultimate Condition of Patentability*

⁴⁶ *Graham v. John Deere Co.* (1966), 383 U.S. 1, 148 USPQ 459. However, the Court acknowledged that by the last sentence of section 103 providing that “*patentability shall not be negated by the manner in which the invention was made*”, Congress intended to abolish the “flash of genius” test announced by the Court in *Cuno Engineering Corp. v. Automatic devices Corp.* The *Cuno* decision had indeed triggered waves of negative commentary, blaming the court for pushing the invention standard to high.

⁴⁷ *Graham v. John Deere Co.* (1966), 383 U.S. 1, 148 USPQ 459, at 11

with inventive inputs and the other which has to do with inventive outputs. *As to inputs, discrete inventions do not typically incorporate a large number of interrelated components; they stand more or less alone. On the output side, the products of discrete technology industries tend not to comprise integral components of some larger product or system; they therefore do not enable the development of a wide array of ancillary products.* Examples of this type of inventions are Gillette's safety razor, the ballpoint pen, and some pharmaceuticals. For such inventions, a patent can indeed offer high and broad control of a particular invention in addition to providing a descent profit to the inventing firm. In some situations these patents do not act as serious restrictions to follow-on inventive work undertaken by other firms.⁴⁸ However, as we will see below, this "discrete innovation model" concerns only one segment of inventive activity. This is despite the fact that much of the writing on patent law only refers to this model.

In this section, I have reported how intellectual property laws, in particular patentability requirements, have traditionally attempted to foster the production of knowledge by identifying those inventions for which the benefits of the incentive effects of a property right exceed the costs of underuse. However, this is only one branch of the balance. IPRs and the market only provide one fraction of knowledge production, an additional research effort is provided by public funds.

2.2 The Distribution of Research Activities between Open Science and Proprietary Technology

In this section, I examine how economics suggest distributing research activities between Technology and Science. Then I turn to discuss how intellectual property law attempts to organize the distribution of research activities. Finally, I look at the organization of knowledge exchanges within Science.

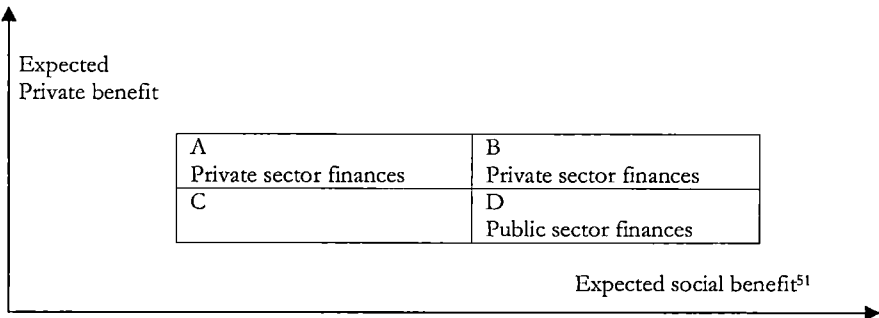
2.1.1 The Economic Frontier: Upstream

Even if innovation is not a linear activity, schematically, it can be seen as a chain that starts upstream with fundamental discoveries made by basic research, and continuing downstream with applied research exploring possible applications of those discoveries, ending with the introduction

⁴⁸ Robert P. Merges & Richard R. Nelson (1990), «On the Complex Economics of Patent Scope », 90 COLUMBIA LAW REVIEW 839, p. 880

of discovery-incorporating products in the market⁴⁹. Economist Paul David likens basic researchers to “*providers of maps to guide mission-oriented researchers, directing explorers on the applied science frontier to the more fruitful areas, and sparing them the wastage of time and resources in searching barren regions or trying to cross unbridgeable chasms*”⁵⁰.

Traditionally, the upstream part of the innovation chain (basic research or “science”) is associated with (i) public funding and (ii) open dissemination. These two attributes are closely related but not totally coextensive. There exists some publicly funded research that is not published (military research) and some privately executed research that is published in peer-reviewed journals or made publicly available in some other way.



From the point of view of funding, the production of knowledge will be funded by the private sector as long as a minimal rate of return can be expected (boxes A and B on the table). Commercial expectations, fixed costs and the ability to make knowledge exclusive are the main variables of private benefit. The public sector finances research where the expected social benefit is high and the private benefit low (box D). Box C depicts research with small expectations of both private and social benefit; these activities are unlikely to be financed as long as the benefits

⁴⁹ Actually, the relationship between basic research and applied research is somewhat circular in the sense that applied knowledge is also a source of inspiration for pure knowledge, which in turn is a source for additional applied knowledge and so forth. See Nathan Rosenberg (1976), *Perspective on Technology*, Cambridge: Cambridge University Press

⁵⁰ Paul A. David (1993), “Knowledge, Property and the System Dynamics of Technological Change” in L. Summers and S. Shah (eds.) *Proceedings of the World Bank Annual Conf. on Development Economics: 1992*, Washington D.C., World Bank Press, p. 230

⁵¹ Adapted from Brown K.M. (1998), *Downsizing Science*, The AEI Press, Washington D.C., by Dominique Foray (2000), *L’économie de la connaissance*, p. 78

expected stay at this low level. For the most part, basic research corresponds to Box D.⁵²

The expected private benefit from basic research is low for different reasons identified by the economics of science.⁵³ First, the economic value of basic research is difficult to forecast and even to assess retrospectively. As basic research occurs at the limits of knowledge, its outcome is highly uncertain. Second, the difficulty in establishing and defending property rights in the discoveries of basic research often impedes the realization of economic rent.

The boundary between Science and Technology is neither immutable nor perfectly precise. The frontier between boxes B and D can move downwards for instance if the exclusivity of certain goods is strengthened; it can move upwards if commercial expectations disappear. This frontier is not well defined and the zone around often depicts a type of research that departs from the pure basic research with an applied direction.⁵⁴ For this type of research, the institutional arrangements are less stable; they can vary according to technological change or national cultures. In the United States, this type of research is mainly done by private research centers while in some European countries it is realized by the government or public organizations. (*Cf. Infra*)

From the viewpoint of dissemination, there are some situations where the benefits derived from new knowledge should not be appropriated by a private entity: this knowledge (on the table: extreme right of box B) is so fundamental and is the source of so many socially useful applications that it would be dangerous to leave its potential to a private agent.⁵⁵ Typically, basic research findings (upstream) are the source of a multitude of useful inventions (downstream), which is why it is traditionally thought that they be freely available.

2.2.2 The Legal Frontier: Upstream

Traditionally, patent law doctrine has attempted to distinguish upstream and downstream elements of the innovation chain by confining the reach

⁵² Dominique Foray (2000), *L'économie de la connaissance*, pp. 78-79

⁵³ Paul A. David, D.C. Mowery & W.E. Steinmueller (1992), "Analyzing the Economic Payoffs from Basic research", 2 *ECONOMICS OF INNOVATION AND NEW TECHNOLOGY* 73-90.

⁵⁴ Dominique Foray. (2000), *L'économie de la connaissance*, p.79

⁵⁵ *Ibidem*

of patent protection to inventions of applied technology, as distinguished from those of basic research.

In American law, the frontier derives from the Constitution. It authorizes Congress to promote the progress of science and arts by securing for authors and inventors, for a limited time, the exclusive rights to their respective writings and discoveries. This constitutional provision is usually read distributively:⁵⁶ the function of patent law is to promote the progress of “useful arts” (i.e. applied technology) by securing for “inventors” exclusive rights to their “discoveries”;⁵⁷ the function of the copyright law is to promote the progress of “Science” (i.e. knowledge in general) by securing for “authors” exclusive rights to their “writings”.⁵⁸ Under this reading, the American Constitution only authorizes Congress to extend patent protection to inventions in applied technology.

Accordingly, Congress has defined patentable subject matter so as to limit patent protection to applied technology. The patent statute defines as patentable: “*Any new and useful process, machine, manufacture or composition of matter, or any new and useful improvement thereof*”.⁵⁹ Among the conditions for patentability, the “utility requirement” plays a crucial role in mediating the boundary between academic science and applied commercially valuable technology.⁶⁰ In application of this requirement, the case law has denied protection to theoretical and abstract discoveries,⁶¹ laws of nature, products of nature,⁶² principles, abstracts ideas, mathematical formulae, and algorithms.⁶³ Patents are granted only

⁵⁶ Rebecca S. Eisenberg (1987), “Proprietary Rights and the Norms of Science in Biotechnology Research”, THE YALE LAW JOURNAL, vol. 97, n°2 (December) p. 185, hereafter Rebecca S. Eisenberg (1987), “Proprietary Rights and...”

⁵⁷ The use of the term « discoveries » in this context does not have the same meaning as in European law where “discoveries” are opposed to “inventions” and are not patentable.

⁵⁸ See, e.g. *Diamond v. Chakrabarty*, 447 U.S.303 (1980): “The constitutionally-stated purpose of granting patent rights to inventors for their discoveries is the promotion of progress in “useful Arts”, rather than in science(...) the present day equivalent of the term “useful Arts” employed by the Founding Father is “technological arts”

⁵⁹ 35 U.S.C. § 101

⁶⁰ Robert P. Merges(1996), « Property Rights Theory and The Commons : The Case of Scientific research”, in Ellen Frankel Paul, Fred D. Miller, JR., and Jeffrey Paul (eds.) *Scientific Innovation, Philosophy, and Public policy*, Cambridge: Cambridge University Press, p. 165, hereafter Robert P. Merges (1996), « Property Rights Theory and The Commons...”

⁶¹ *Mackay Radio & Tel. Co v. Radio Corp. of Am.*, 306 U.S. 86, 94 (1938)

⁶² *Funk Bross. Seed Co v. Kalo Inoculant Co.*, 333 U.S. 127 (1948)

⁶³ *Gottshalk v. Benson*, 409, U.S. 63 (1972); *Parker v. Flook*, 437 U.S. 584 (1978)

for the discovery of new means to achieve useful results. To the extent that basic research consists of explanations for existing means of achieving useful results, or principles that are only put into use later by works of others, it may not be patented.⁶⁴ Thus, using Professor Eisenberg's expression, the "utility requirement" can be seen as "*a timing device helping to identify when an invention is ripe for patent protection*".⁶⁵

This view is expressed by the last Supreme Court case addressing the utility requirement, *Brenner v. Manson*⁶⁶.

The facts: On October 13, 1959 Howard Ringold and George Rosenkrantz obtained a patent on a novel process for making a known steroid. Their patent described the useful effect that the products of their invention had for the treatment of some ailment. Three months later, Andrew Manson filed a patent application for the same process in order to win a patent and to invalidate the Ringold Patent. To do so, Manson needed to prove that he had created the process and established a utility prior to the date on which Ringold and Rosenkrantz filed their first patent application (December 17, 1956).

The decisions: (1) The patent examiner rejected Manson's application on the ground that he had failed to show that he knew the utility of the steroid product at that date. Manson tried to overcome the obstacle referring to an article anterior to the first patent application revealing that a number of compounds, including the relevant steroid, were being tested for possible tumor inhibiting effect and that a compound closely related to Manson's steroid had proven effective. (2) Despite this piece of evidence, the Patent Office's Board of Appeal upheld the rejection of Manson application, stating that: "*it is in our view that the statutory requirement of usefulness of a product cannot be presumed merely because it happens to be closely related to another compound which is known to be useful*". (3) The Court of Customs and Patent Appeals (CCPA) reversed the decision and affirmed that "*where a claim process produces a known product it is not necessary to*

⁶⁴ Rebecca S. Eisenberg (1987), "Proprietary Rights and..." p. 186

⁶⁵ Rebecca S. Eisenberg (2000), « Analyze this ... », p. 2087

See also William M. Landes and Richard A. Posner (2003), *The Economic Structure of Intellectual Property Law* (...), stating that: "*The requirement of utility can be understood to have three economic purposes. One is to rule out patents on basic research, and another is to delay the point in the development of a new product or process at which a patent may be obtained (...) The third is to reduce the cost of patent searches by screening out useless inventions by cranks or amateurs, or by inventors hoping to blanket an area of research with patents in the hope of forcing researchers who come up with useful invention within the area to seek licenses from them. In other words, the requirement if utility serves to limit strategic patenting.*" (p. 302)

⁶⁶ *Brenner v. Manson*, 383 U.S. 519 (1966)

show utility for the product” as long as the product “is not alleged to be detrimental to the public interest”. (4) The Supreme Court reversed the decision of the CCPA, reaffirming the importance of the utility requirement. In addition, this case is very interesting to the extent that the Court perfectly described what is at stake in a possible upstream shift in patenting:

“It is true, of course, that on of the purpose of the patent system is to encourage dissemination of information concerning discoveries and inventions. And it may be that inability to patent a process to some extent discourages disclosure and leads to a greater secrecy that would otherwise be the case. The inventor of the process, or the corporate organization by which he is employed, has some incentive to keep the invention secret while uses for the products are searched out. However, in light of the highly developed art of drafting patent claims so that they disclose as little useful information as possible –while broadening the scope of the claim as widely as possible – the argument based upon the virtue of the disclosure must be warily evaluated. Moreover, the pressure for secrecy is easily exaggerated, for if the inventor of a process cannot himself ascertain a “use” for that which his process yields, he has every incentive to make his invention known to those able to do so. Finally, how likely is a disclosure of a patented process to spur research by others into the uses to which the product may be put? To the extent that the patentee has power to enforce his patent, there is little incentive for others to undertake a search for uses;

Whatever weight is attached to the value of encouraging disclosure and of inhibiting secrecy, we believe a more compelling consideration is that a process patent in the chemical field, which has not been developed and pointed out to the degree of specific utility, creates a monopoly of knowledge which should be granted only if clearly commanded by the statute. Until the process claim has been reduced to production of a product shown to be useful; the metes and bound of that monopoly are not capable of precise delineation. It may engross a vast, unknown, and perhaps unknowable area. Such patent confer power to block off whole areas of scientific development, without compensating benefit for the public. (...)”

After this very up-to-date analysis of what is at stake in determining the appropriate level of development required prior to granting a patent to an invention, the Court annunciated a rigorous test requiring “substantial utility” – a specific benefit must exist and be available when the application is filled-- and the Court affirmed its rejection of upstream patents.

“That is not to say that we mean to disparage the importance of contributions to the fund of scientific information short of the invention of something “useful”, or that we are blind to the prospect that what

now seems without “use” may tomorrow command the grateful attention of the public. But a patent is not a hunting license. It is not a reward for the search, but compensation for its successful conclusion. “A patent system must be related to the world of commerce rather than to the realm of philosophy...”⁶⁷

This decision, however, was not unanimous and it is likely that the dissenting opinion advances arguments that will reappear in future litigation. (*Cf. infra*).

In Europe, the situation is roughly similar, even though the criteria for patent protection are phrased in different terms. Article 52 (1) of the Munich European Patent Convention (EPC) lists the four criteria for patent protection: “*European patents shall be granted for any inventions which are susceptible of industrial application, which are new and which involve inventive step.*”⁶⁸ The European Patent Office (EPO) guidelines add two further requirements that are implicitly contained within the EPC. First, “*the invention must be such that it can be carried out by a person skilled in the art.*”⁶⁹ Second, “*the invention must be of ‘technical character’ to the extent that it must relate to a technical field, must be concerned with a technical problem, and must have technical features in terms of which the matter for which protection is sought can be defined in the claim*”.⁷⁰

In European law, both the distinction between “discovery” and “invention” and, to some extent the condition of “industrial applicability” assume roughly the same boundary function⁷¹ as the “utility requirement” in American law. The EPC gives no definition of “invention” but Article 52 (2) contains a non-exhaustive list of elements which are not regarded as inventions: a) discoveries, scientific theories and mathematical methods; b) aesthetic creations; c) schemes, rules and

⁶⁷ My emphasis

⁶⁸ Article 27 of the TRIPS Agreement includes a footnote indicating that the terms “capable of industrial application” and “involve and inventive step” may be deemed by a member to be synonymous with the terms “useful” and “non-obvious”, respectively.

⁶⁹ This condition comes from the disclosure requirement.

⁷⁰ EPO, *Examination Guidelines*, part C, Chapter 4, available at www.european-patent-office.org. Actually, this is more in line with the definition of invention than with the definition of discovery, rather than a separate and additional criterion.

⁷¹ See notably Michel Vivant (ed.) (2003), *Protéger les innovations de demain. Biotechnologies, logiciels et méthodes d'affaire*, Institut National de la Propriété Industrielle, coll. « Propriété intellectuelle », Paris, La Documentation Française, p. 43, hereafter Michel Vivant (ed.) (2003), *Protéger les innovations de demain (...)*, or Bernard Bergmans (1991), *La Protection des Innovations Biologiques. Une étude de droit comparé*, Larcier, Bruxelles, p. 224

methods for performing mental acts, playing games or doing business, and program for computers; d) presentations of information. The EPO guidelines observe that the items on this non-exhaustive list of things which are not regarded as invention are all either abstract and/or non-technical. Therefore, the EPO deduces that by contrast an invention must be of both a concrete and technical character. The invention is opposed to the “discovery” that consists of observing something already existing but not yet observed: for instance, a new physical principle, an unknown property of a substance, etc.⁷² Consequently, discovering a new property of a material (Science) cannot be patented but applying this property in a practical goal (Technology) can.

Article 57 of the Munich Convention defines the condition of industrial application in the following terms: “*An invention shall be considered as susceptible of industrial application if it can be made or use in any kind of industry, including agriculture.*” The EPO Guidelines indicate that the term “industry” should be understood in a broad sense including any physical activity of a technical character. This criterion implies that the invention has to have a practical application. There is little case law on this issue likely because this condition poses little difficulty and is somewhat similar to the invention-discovery distinction, which is settled in the law. Indeed, the EPO views this criterion as redundant, considering that those inventions it would exclude from patentability are already excluded by the Article 52 (2) list.⁷³

2.2.3 Within Science: the Norms of Science

After analyzing how research activities are distributed between (publicly funded) Science and (IPR protected) Technology, it is worth examining how knowledge is diffused and shared within Science. Indeed, knowledge, or research results obtained by scientists are not automatically publicly available. Public funding of basic research, patent law and the prevailing wisdom that private ownership of inventions

⁷² EPO, *Examination Guidelines*, part C, Chapter 4, available at www.european-patent-office.org

⁷³ According to the EPO Guidelines (following the unpublished decision T 541/96), one further class of invention which would be excluded would be articles or processes alleged to operate in a manner clearly contrary to well-established physical laws e.g. a perpetual motion machine, EPO Guidelines C IV 4.1. The requirement of industrial application also excludes methods that fall entirely within the private or personal sphere of a human being; see T 0074/93, “British Technology Group/Contraceptive Method”, decision of Technical Board of Appeal 3.3.1, 9 November 1994, OJ EPO, 1995, 712.

made through public funding was contrary to public interest, have long disinclined basic research scientists to secure patents. But this disinclination also had a normative component: claiming exclusive rights on research discoveries was considered as contrary to scientific norms. Sociologists of science have described the norms and incentives that guide the behavior of scientists. Robert Merton identified the goal of science as “the expansion of certified knowledge”, and the methodology to reach that goal as empirical research. Then, he describes four “norms of science” that are derived from this goal and this methodology: (i) universalism, (ii) communism or communalism, (iii) disinterestedness and (iv) organized skepticism. In short, “universalism” means that impersonal criteria, independent of the identity and characteristics of the scientist who executed the research, are used to assess the validity of the scientific work; “communism” or “communalism” means that scientific findings are a common heritage, in the sense that they are a product of social collaboration. The communal dimension of science also includes recognition by scientists of their dependence on a cumulative common heritage. All discoveries are built on what was learned before and contribute to what may be learned in the future. Accordingly, they are made open to all. According to Merton, claiming property rights or keeping secrets are often seen as immoral in the scientific community. The individual scientist’s intellectual property is limited to recognition and esteem. “Disinterestedness” means that scientists seek truth rather than self-interest, that they ideally are indifferent to the success of an experiment or the reception of research finding; “organized skepticism” means that the scientific community rigorously tests research findings before accepting them as true.⁷⁴ Obviously, these norms are not a perfect description of how scientists actually do behave; rather, they are socially inculcated beliefs among scientists about how they should behave. Deviations from these norms are not uncommon.

Finally, Merton describes a scientific reward system that fortifies these norms. Indeed, the knowledge produced in research activities is not inherently public; there is the potential for it to remain secret if a researcher is concerned about the theft of his ideas. According to Merton, it is the reward system that determines which information is fully disclosed, partly disclosed, or kept secret. The reward system rests

⁷⁴ Robert K. Merton (1973), *The Sociology of Science*, Chicago: University of Chicago Press, especially the chapter on “The Normative Structure of Science”, for a brief summary see Rebecca S. Eisenberg (1987), “Proprietary Rights and...”, p. 182-3 or Robert P. Merges (1996), « Property Rights Theory and The Commons... », p. 148, or Arti K. Rai (1999) “Regulating Scientific Research: Intellectual Property Rights and the Norms of Science” 94 NORTH WESTERN LAW REVIEW 77, pp. 89-92, hereafter Arti K. Rai (1999) “Regulating Scientific Research...”

on the “rule of priority” of discovery. The rule of priority identifies the author of a discovery only once he publishes his findings. . This rule creates a kind of “moral property” that is the basis for the accumulation of ‘reputation capital’ that plays a decisive role in the attribution of research funding and ultimately a scientist’s career. Thus, the rule of priority serves two purposes: (i) hastening discoveries and (ii) hastening their disclosure. First, combining rewards with priority sets up a race for scientific discoveries. Second, the rule of priority elicits public disclosure of new findings. Consequently, the rule of priority is an interesting answer to the knowledge dilemma; it creates privately owned assets from the act of relinquishing exclusive possession of the new knowledge.⁷⁵

In this chapter, I have described a two-part balance, first in the distribution of research activities between Technology and Science, and second in the combination of incentives to produce and share knowledge within both Technology and Science. In the following chapter, I examine how this two-part balance has been modified.

⁷⁵ Partha Dasgupta & P. A. David (1994), “Toward a New Economics of Science”, pp. 499-500

3. A Two-Part Transformation

In the previous chapter I described the equilibrium historically created by the norms of science and intellectual property law's two-part balance: (i) the distribution of research activities between Technology (IPRs and the market) and Science (public funding and open access), and (ii) the combination of incentives to produce and share knowledge within both Technology and Science. In this chapter, I examine how this two-part balance has been modified and I hypothesize that changes in intellectual property law can be explained by changes in innovation policy as well as innovative process.

3.1 Sources of Changes

In this dissertation, I adopt a utilitarian or instrumental approach, according to which IPRs are not regarded as non-modifiable natural rights. Rather, I consider IPRs as instruments of innovation policy. Therefore, intellectual property law may always be amended according to the evolving objectives of governments' innovation policy. Change in innovation policy is a primary source of legal change. The Bayh-Dole Act and similar legislation that encourage public research organizations to patent publicly funded inventions is an example of such change (*Cf. section 3.2.2*)

Change in innovation process constitutes a second source of change to intellectual property laws. Property rights can solve problems of collective action by reducing the risk of overuse (a minor issue for knowledge goods) and inducing investment in costly activities (a major issue). However, creating a property rights system is costly for society, and the enforcement of property rights is costly both for society and individual economic actors. With specific regard to patent law, the creation of a patent system is costly for society because it reduces access to knowledge (deadweight loss) and because it requires the creation and the maintenance of an administrative and judicial system. From the standpoint of individual economic agents, getting a patent and enforcing it against infringers is also costly. Consequently, a trade-off must be made between the costs and benefits of creating a property regime and enforcing the property rights created by such a regime.

Changes in the innovation process modify these costs and benefits. Technological changes can increase the benefits of creating and enforcing property rights (e.g. the emergence of a new promising

technology and the need to invest in its development). Similarly, the costs of creating and enforcing property rights can also be reduced by technological change (e.g. anti-copy devices) or organizational progress (e.g. the creation of European or international patent application processes). After such change, a rational society is likely to adapt its property regime. As the costs of creating and enforcing property rights evolve and as scarcity of resources and need for investment increase, a property regime must be modified in order to remain efficient. This is the central argument made by Harold Demsetz in its article "Towards a Theory of Property Rights"⁷⁶.

Demsetz's theory is sometimes referred as the "naive theory of property rights"⁷⁷ as it suggests that changes in the definition of property rights are automatic and always efficient. Historical records tend to show that these changes are neither automatic nor complete. What Demsetz omitted is politics; governments (or courts) are the main creators of property rights. Accordingly, Demsetz's hypothesis has been qualified to account for the persistence of inefficient property rights. As an illustration, the economic historian and Nobel Prize winner, Douglass North also considers that economic agents (organizations) respond to changing perceived costs and benefits *either directly, by devoting resources to new profitable opportunities or indirectly [...] by estimating the costs and benefits of devoting resources to altering the rules or enforcement of the rules.*⁷⁸ He nevertheless accounts for inefficient property rights and suggests that the definition of efficient property rights is hampered by the inefficiencies of the political market, i.e. differences in bargaining power among different constituencies, and limited information available to governments.⁷⁹ Despite these qualifications, it remains fairly true that the pattern by which property rights emerge and grow is related to their cost-benefit ratio. Moreover, it is important to keep in mind that it is not only society that has to consider the costs and benefits of creating and enforcing property rights but individuals must do so as well. For instance, if the law grants patents for inventions, then the inventor has to decide whether it is worthwhile to apply for a patent and whether it is worthwhile to enforce the patent if it should become infringed.

⁷⁶ Harold Demsetz (1967) in "Towards a Theory of Property Rights" 57 AMERICAN ECONOMIC REVIEW 347

⁷⁷ Thrainn Eggertsson (1990) *Economic Behavior and Institutions*, Cambridge University Press, p. 271

⁷⁸ Douglas C. North (1990), *Institutions, Institutional Change and Economic Performance*, Cambridge: Cambridge University Press, p.87

⁷⁹ *Ibidem*, p. 52

In the next section of this Chapter I will identify some changes in innovation policy and innovation processes. I will further examine how these changes have affected intellectual property law first within the realm of Technology and then within in the realm of Science.

3.2 Inside Proprietary Technology

3.2.1 Changes in the Innovation Process

During the twentieth century and particularly in the last several decades, one can observe important changes in the innovation process. In place of breakthrough or “pioneer” inventions that characterized the industrial revolution, it is increasingly the “routine engineers” cumulative and sequential work, emerging from shared technical trajectories, that drives today’s economy in Silicon Valley. ⁸⁰ It is argued that this transformation consists of three related dimensions: (i) innovation is increasingly cumulative, (ii) an increasing number of inventions are small-scale, and (iii) it is increasingly easy to copy inventions.

First, the innovation process is decreasingly made up of discrete and well-defined inventions, created through the inventor’s insight and hard work. Rather, a major part of today’s technical advances are regarded as cumulative or collective. That is to say that *today’s advances build on and interact with many other features of existing technology (...)* In any case, *the technology in question defines a complex system with many components, subcomponents and parts, and technical advance may proceed on a number of different fronts at once. In these industries, inventions may enhance some features of a prior “dominant design”, or they may be incorporated into subsequent inventions or both.* ⁸¹ There are different forms of sequential links between cumulative innovations: an invention can increase the quality of an existing product, reduce the production costs of an existing product, consist of a “new use” of an exiting product, and can be a research tool for further inventions. The cumulative and sequential character of innovation is not something new. When George Selden obtained a patent in 1895 for the first vehicle moved by an internal combustion engine, he launched an innovation chain that exists today in our motor vehicles, and continues to evolve. Nevertheless, one can observe the increasing cumulative character of innovation namely in the software industry and in

⁸⁰ Jerome H. Reichman (2000), “Of Green Tulips and legal Kudzu: Repacking Rights in Subpatentable Innovation”, 53 VANDERBILT L. REV. 1743 p. 1750, hereafter Jerome H. Reichman (2000), “Of Green Tulips...”

⁸¹ Robert P. Merges & Richard R. Nelson (1990), “On the Complex Economics of Patent Scope” (...) p. 882

biotechnology.⁸² Software source codes are made up of programming elementary “bricks” that can be used in different programs. Moreover, they are written in programming languages that are themselves innovations. In the field of biotechnology, the cumulative dimension of innovation stems from the importance of research tools, which emerge from fundamental research.

Second, an increasing part of the output of R&D activity is incremental. It is made up of small-scale (or sub-patentable) inventions that do not meet the traditional “inventive step” or “non-obviousness” thresholds. Actually, an important part of what engineers produce today is rather small-scale technical know-how-- a store of information about methods or processes of production that confers some commercial advantages on their possessors.⁸³ For example, gene sequencing in biotechnological research proceeds automatically from systematic analysis carried out by a computer through a routine operation.

Third, an increasing part of the output of R&D activity is costly to develop but vulnerable to rapid and cheap duplication. As Professor Reichman⁸⁴ points out, this problem first arised at the end of the nineteenth century in the realm of industrial design. Industrial designs are functional or aesthetic features incorporated into mass-produced products that aim to enhance the product’s consumer desirability.⁸⁵ Innovative industrial designs generally consist of small variations on or new combinations of pre-existing elements, established themes, or style trends. These variations cannot be protected by patent as they usually do not meet the “inventive step” or “non-obviousness” standard. Moreover, because the designer’s innovative know-how or innovation is in its nature embodied in the end product, the designer is deprived from actual or legal secret protection. Consequently, designers lack sufficient market lead-time during which they may recover their investment.

⁸² See e.g. Walter W. Powell (2001), “Networks of Learning in Biotechnology: Opportunities and Constraints associated with Relation Contracting in a Knowledge-Intensive Field”, in Rochelle Dreyfus *et al.* (eds.), *Expanding the Boundaries of Intellectual Property: Innovation Policy for the Knowledge Society*, Oxford University Press, New York, pp. 251-266

⁸³ Jerome H. Reichman (2000), “Of Green Tulips ...” p. 1750. See also François Magnin (1974) *Know-How et Propriété industrielle*, or Mireille Buydens (1993), *La Protection de la Quasi-cr  ation*, Larcier-Bruylant-FEC, Bruxelles

⁸⁴ Jerome H. Reichman (1994) “Legal Hybrids...” p. 2512

⁸⁵ William Cornish & David Llewellyn (2003), *Intellectual Property : Patents, Copyrights, Trade Marks and Allied Rights*, ... p. 535

In the nineteenth century and in the first part of the twentieth century, this problem was relatively limited as most innovative works, other than industrial design, could benefit from patent, copyright or trade secret protection.⁸⁶ Since the middle of the twentieth century, like industrial design, innovations increasingly became relatively cheap and easy to copy. The most obvious examples of this trend are the semiconductor chip, plant breeding, and more recently software. Conventionally, a manufacturer can sell a machine without transferring the know-how involved in manufacturing the machine; whereas anyone who comes into possession of a new plant variety seed or a computer program also gains possession of the manufacturing know-how required to reproduce identical seeds or computer programs. Recently, the importance of this phenomenon of duplication vulnerability has increased, notably with the development of digital technologies.⁸⁷ This phenomenon not only destroys the potential for protection through secrecy, but also increases the cost of monitoring and sanctioning violations of IPRs. Indeed, the easier it is to copy, the more difficult it is to identify copiers and to enforce the property right.

In sum, an evolution in the innovation process is clearly observed. This transformation lies notably in the fact that innovation is increasingly cumulative, collective, incremental and vulnerable to duplication.⁸⁸ In the next subsection I will briefly analyze how the law has adapted to this evolution.

3.2.2 Changes in Intellectual Property Law

In accordance with Demsetz's and its successors' hypothesis, intellectual property law has adapted to these technological changes. Out of the three changes identified, two seems to have played a major role in legal change: (i) incremental innovations and (ii) innovations that are vulnerable to duplication.

Professor Reichman identifies two reactions in the intellectual property legal system. Governments or courts tend to respond by either extending patent and copyright laws to protect subject matter for which those laws were not intended, or by implementing hybrid legal regimes

⁸⁶ Jerome H. Reichman (1994) "Legal Hybrids..." p. 2512

⁸⁷ Actually, digitalization not only makes copying easy but it also makes copying a *sine qua non* condition of transmission, storage and even reading of digital material.

⁸⁸ Professor Reichman summarizes these evolutions by the expression "Incremental innovation bearing know-how on its face".

that grant exclusive property rights to new objects of protection that fall outside the classical legal framework.⁸⁹

3.2.2.1 The First “Strategy”

The first strategy consists in lowering the inventiveness or non-obviousness standard in patent law, and expanding the copyright paradigm previously intended for artistic work to include industrial and/or functional works as well. As for patent law, this evolution is difficult to document, as it has been rather implicit. Part of this evolution has occurred without change in statute law; moreover neither patent offices nor courts mention intent to lower the patentability requirements.

In a study entitled “The U.S. Patent System in Transition: Policy Innovation and the Innovation Process,”⁹⁰ Adam B. Jaffe notes that *with respect to any given patent, there are often disagreements as to whether the “inventive step” embodied in the patent is large enough to justify a finding that the invention is not obvious and hence is entitled to a patent. In recent years, however, there has been a widespread sense that the patent office is granting large numbers of patents on trivial inventions.* Jaffe adds: *I am not aware of any attempt to document this phenomenon systematically; indeed, it is not clear to me how it could be done.* Even if this lowering of the non-obviousness requirement is not fully documented, one can point out two sets of doctrinal changes in patent case law, especially by the Federal Circuit⁹¹ that contribute to this demise of the non-obviousness requirement.

The first set of doctrinal changes concerns the “suggestion tests” used in the appreciation of the difference between the claimed invention and the prior art. One can identify two evolutions in the use of suggestion tests, one concerns all inventions, and the other applies to “combination patents”. Until a few decades ago, the accepted suggestion test to assess obviousness was “obvious to try”. Courts found inventions obvious and therefore non-patentable when given the prior art it was obvious to try the research approach followed by the inventor. As an illustration, courts

⁸⁹ Jerome H. Reichman (1994) “Legal Hybrids...” p. 2444, citation omitted. *See also* Jerome H. Reichman (2003), “Saving the Patent Law from Itself...”, and Jerome H. Reichman (2000), “Of Green Tulips...”

⁹⁰ Adam B. Jaffe (2000), “The U.S. Patent System in Transition: Policy Innovation and the Innovation Process”, 29 RESEARCH POLICY 531, at 549

⁹¹ The Court of Appeals of the Federal Circuit was created by the Federal Courts Improvement Act of 1982 to hear all patent appeals. Its creation was driven by Congress’s desire to unify and strengthen patent law. It is generally believed to have a strong pro-patent stance.

held that inventions were obvious because “*certainly, it would be obvious to try it and mere proof that it worked would not make it patentable*”⁹² or because given the prior art “*it is not surprising to that the inventors would begin experimenting with various substance, including the claimed compound*”.⁹³ Yet since the 1960s, the “obvious to try” standard has been progressively replaced by the “reasonable expectation of success” standard. This new standard adds a second condition to reject a patent claim for obviousness. Prior art must not only suggest a research approach but also that the approach would be successful.⁹⁴

In addition, the Federal Circuit also modified the suggestion test used specifically for “combination” patents. This is very relevant in a context of collective and cumulative innovation. For the assessment of the non-obviousness of a claimed invention consisting of a combination of elements already found separately in the prior art, the Supreme Court had suggested in several decisions a “synergism requirement”: *We cannot agree that the combination of these old elements [...] can properly be characterized as synergistic, that is “result(ing) in an effect greater than the sum of the several effects taken separately”*. Rather, *this patent simply arranges old elements with each performing the same function it had been known to perform, although perhaps producing a more striking result than in previous combinations. Such combinations are not patentable under standards appropriate for a combination patent.*⁹⁵ Consequently, the Supreme Court has tended to presume that patents based on combinations of prior art elements are obvious.⁹⁶

However, since its creation in 1982, the Federal Circuit has refused to apply the “synergistic requirement”, holding that there is no statutory basis for identifying “combination” patents and has applied a more stringent obviousness test to such patents.⁹⁷ Considering that “*virtually all*

⁹² *In re Ruscetta*, 255 F.2d 687, 692, 118 U.S.P.Q. (BNA) 101 (1958)

⁹³ *Mandel Bros. v. Wallace*, 335 U.S. 291, 295 (1948)

⁹⁴ *In re Tomlison*, 363 F.2d 928, 150 U.S.P.Q. (BNA) 623 (C.C.P.A. 1966) and *In re Fine*, 837 F.2d 1071, 1075, 5 U.S.P.Q. 2D 1596 (Fed. Circuit 1988). For a description of the test by the court, see *Brown & Williamson Tobacco Corp. v. Philip Morris, Inc.*, 229 F.3d 1120, 1124-1125, 56 U.S.P.Q. 2D (BNA) 1456 (Fed. Circuit 2000)

⁹⁵ *Sakraida v. AG Pro Inc.*, 425 U.S. 273, 282 (1976), the last Supreme Court decision on the substance of the nonobviousness requirement. The “synergistic requirement” had been first formulated before the enactment of Section 103 of the Patent Act in *Great A. & P. Tea Co. v. Supermarket Corp.* 340 U.S. 147, 153 (1950) and reaffirmed in *Anderson's Black Rock, Inc. v. Pavement Salvage Co.*, 396 U.S. 57, 61 (1969)

⁹⁶ See *Graham v. John Deere Co.*, 383 U.S. 1, 34-37 (1966)

⁹⁷ *Medtronic, Inc. v. Cardiac Pacemakers, Inc.*, 721 F.2d 1563, 1566 (Fed. Cir. 1983); see also *Chore-Time Equip., Inc. v. Cumberland Corp.*, 713 F.2d 774, 781 (Fed. Cir. 1983)

*inventions are combinations and virtually all are combinations of old elements,*⁹⁸ the Federal Circuit asserted that an invention combining elements from different prior art references will be deemed obvious, i.e. non-patentable, if the prior art contains some suggestion to combine the elements in the same way.⁹⁹ As observed by Professor Lunney, “*the Federal Circuit’s test essentially reverses the key presumption in these cases. Where all of the elements were known, the Supreme Court presumed that any given combination was obvious, unless there was some reason that suggested otherwise. The Federal Circuit, on the other hand, presumes that any given combination is nonobvious, unless there is some suggestion in the prior art otherwise.*”¹⁰⁰ One can wonder whether in using such a suggestion test, the Federal Circuit is not reducing the non-obviousness requirement to an equivalent of novelty. The Supreme Court will soon have an opportunity to pronounce on this doctrinal change.¹⁰¹ Indeed, after a similar decision of the Federal Circuit,¹⁰² KSR who had unsuccessfully attempted to challenge the validity of patent has petitioned the Supreme Court for a writ of certiorari. The petition is supported by three amicus briefs written respectively by five large corporations including Microsoft, Cisco and Hallmark, twenty-four law professors and the Progress and Freedom Foundation, asserting that the Federal Circuit’s test for “nonobviousness” represents a departure from earlier Supreme Court precedents and results in too many patents that claim obvious inventions. The Court has not yet granted certiorari, but its invitation to the Office of the Solicitor General to express views of the US government suggests that it might.

The second set of doctrinal changes and probably the most important lies in the elevation of secondary considerations such as “commercial success”, “long felt but unsolved needs” and “failure of others” to a central position in the obviousness enquiry.¹⁰³ Whereas the Supreme

⁹⁸ *Environmental Designs v. Union Oil Co.*, 713 F.2d 693, 698 (Fed. Cir. 1983), *cert. denied*, 464 U.S. 1043 (1984)

⁹⁹ See *Robotic Vision Systems, Inc. v. View Eng’g, Inc.*, 189 F.3d 1370, 1377 (Fed. Cir. 1999) stating that the party seeking a holding of invalidity based on a combination of two or more prior art teachings must show some motivation or suggestion to combine the teachings. See also *Micro Chem., Inc. v. Great Plains Chem. Co., Inc.*, 103 F.3d 1538, 1546 (Fed. Cir.1997); *In re Laskowski*, 871 F.2d 115, 117 (Fed. Cir. 1989); *In re Oetiker*, 977 F.2d 1443, 1448 (Fed. Cir. 1992); *Winner Int’l Royalty Corp. v. Wang*, 202 F.3d 1340, 1348 (Fed. Cir., 2000)

¹⁰⁰ Glynn S. Lunney, Jr. (2001), “E-Obviousness” 7 MICH. TELECOMM. TECH. L. REV. 363, p. 379, hereafter Glynn S. Lunney, Jr. (2001), “E-Obviousness”

¹⁰¹ *KSR International v. Teleflex* (On Petition for Certiorari)

¹⁰² *Teleflex Inc. v. KSR Intern. Co.*, 119 Fed.Appx. 282 (Fed. Cir. 2005)(Schall, J.)(non-precedential)

¹⁰³ Glynn S. Lunney, Jr. (2001), “E-Obviousness”, p. 375

Court¹⁰⁴ and the various circuits had relegated secondary considerations to a subsidiary role, the Federal Circuit holds that secondary considerations, or “objective indicia” as they are occasionally referred, are often “*the most probative and cogent evidence of the record.*”¹⁰⁵ The Federal Circuit suggests that economic motivations such as secondary evidence are more susceptible to judicial treatment than highly technical facts. In addition, the Federal Circuit does not require evidence that commercial success is due to the nonobviousness nature of the invention rather than other factors such as marketing or market power.¹⁰⁶ The Federal Circuit has also considered additional secondary factors such as skepticism or disbelief¹⁰⁷, copying,¹⁰⁸ praise, unexpected results, and industry acceptance¹⁰⁹ as indicators of the non-obviousness of a claimed invention. Conversely, the Federal Circuit has been reluctant to use secondary considerations to establish the obviousness of an invention and deny patent protection¹¹⁰.

The growing importance given to secondary factors has been very effective in lowering the role of the non-obviousness requirement—at least for litigated patents. As anticipated by Professor Kitch, the practical effect of this doctrinal change is that most litigated patents are held to be

¹⁰⁴ See *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966) where the Supreme court coined the term “secondary considerations” to designate commercial success, long-felt but unsolved needs, failure of others, etc. and suggested that they “might be utilized” and “may have relevancy” to the obviousness inquiry. See also *Stevenson v. Grentec, Inc.*, 652 F.2d 20, 23 (9th Cir. 1981); or *Digitronics Corp. v. New York Racing Ass’n*, 553 F.2d 740, 748-49 (2d Cir. 1977); or *Sakraida v. Ag Pro, Inc.*, 425 U.S. 273, 282-83 (1976); or *Medical Lab. Automation, Inc. v. Labcon, Inc.*, 670 F.2d 671, 675 (7th Cir. 1981).

¹⁰⁵ *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538 (Fed. Cir. 1983) compare with *Anderson’s Black Rock, Inc. v. Pavement Salvage Co.*, 396 U.S. 57, 61 (1969) saying: “It is, however, fervently argued that the combination filled a long felt want and has enjoyed commercial success. But those matters “without invention will not make patentability.”

¹⁰⁶ *Hybritech Inc. v. Monoclonal Antibodies Inc.*, 802 F. 2d 1367, 231 U.S.Q. 81 (Fed. Cir. 1986). For a critic, see the dissenting opinion of Judge Rich or Robert P. Merges (1988), “Commercial Success and Patent Standards: Economic Perspectives on Innovation”, 76 CALIF. L. REV. 805

¹⁰⁷ *Environmental Designs, Ltd. v. Union Oil Co. of Cal.*, 713 F.2d 693, 697-98, 218 USPQ 865, 869 (Fed. Cir. 1983)

¹⁰⁸ *Diversitech Corp. v. Century Steps, Inc.*, 850 F.2d 675, 679, 7 USPQ2d 1315, 1319 (Fed. Cir. 1988)

¹⁰⁹ *Allen Archery, Inc. v. Browning Mfg. Co.*, 819 F.2d 1087, 1092, 2 USPQ2d 1490, 1493 (Fed. Cir. 1987)

¹¹⁰ See *Custom Accessories, Inc. v. Jeffery-Allan Indus., Inc.*, 807 F.2d 955 (Fed. Cir. 1986) holding that absence of commercial development or other secondary considerations is not evidence of obviousness, but only “a neutral factor” (at 960); or *Environmental Designs Ltd. v. Union Oil Co.*, 713 F.2d 693 (Fed. Cir. 1983), ruling that evidence of near-simultaneous invention by others does not evidence of obviousness (at 698)

valid. Indeed, it is unlikely that patents that are not commercially successful will be brought to litigation. As a result, to the extent that commercial success becomes an important factor in determining a patent's validity, or in other words, the very fact that the patent is worth litigating seems to establish its validity.¹¹¹

In summary, the combination of these two sets of doctrinal changes has led to a demise of the nonobviousness requirement or at least an important lowering of the threshold of inventiveness required. This conclusion is confirmed by an empirical survey of all appellate decisions arising from patent infringement litigation over the last fifty years undertaken by Professor Clunney. This survey first demonstrates that the percentage of patents held to be invalid decreased drastically from forty-five to sixty-five percent in the period before 1980 to twenty-five percent in the 1990s. Second, this survey reveals that for the number of patents held invalid, those that were held invalid on non-obviousness grounds decreased even more sharply from sixty-five to eighty percent in the period before 1980 to twenty percent in the 1990s.¹¹²

Although it is difficult to document it seems that the trend of lowering the inventive step requirement is also present in **European patent law**. However, the European Patent Office (EPO) and some national courts have been slightly more reticent vis-à-vis this evolution.

As for a suggestion test, the EPO also moved from "obvious to try" to "reasonable expectations of success" as the standard to assess obviousness. In the early 1980s, several decisions of the EPO seemed to equate "obvious to try" with obvious, holding that "*It is part of the normal activities of the person skilled in the art to select the most appropriate of a group of materials known as suitable for a particular purpose.*"¹¹³ However, more recent cases emphasize that the proper obviousness test is whether the inventor's approach would "obviously succeed", not whether it was

¹¹¹ Edmund Kitch (1966), "*Graham v. John Deere Co.* : New Standards for Patents" SUPREME COURT REV. 293

¹¹² See detailed figures in Glynn S. Lunney, Jr. (2001), "E-Obviousness"

¹¹³ T 21/81 *Electromagnetically Operated Switch/ Allen-Bradley* (Sept. 10, 1982) OJ EPO, 1983, 15; see also T 67/83 (Aug. 1, 1984), unpublished; and T 235/85 *Fibre Manufacture/ Akzo*, (Feb. 10, 1987) OJ EPO, 1987, 198

obvious to try.¹¹⁴ And the EPO added that “a reasonable expectation of success should not be confused with the understandable ‘hope to succeed’; it implied the ability of the skilled person to predict rationally, on the basis of the knowledge existing before a research project was started, the successful conclusion of the said project within acceptable time limits”.¹¹⁵

As to combination patents, contrary to the American Federal Circuit, the EPO continues to apply the “synergistic requirement”. It distinguishes a mere aggregation or juxtaposition of features that are not patentable from a combination invention that “requires that the relationship between the features or group of features be one of functional reciprocity or that they show a combinative effect beyond the sum of their individual effect”.¹¹⁶ However, in the application of the suggestion test, the EPO’s approach parallels that of American Courts. An invention combining elements from different prior art references will be deemed obvious only if the prior art was such as to suggest precisely the combination of features claimed.¹¹⁷

The treatment of secondary considerations by the EPO and European Courts is similar to the one applied in the United States but slightly less receptive. The EPO acknowledges that evidence of commercial success is useful to appreciate the inventive activity,¹¹⁸ but it is more demanding than its American counterpart in verifying that commercial success is due to technical factors rather than other business factors.¹¹⁹ The EPO and Courts have been more receptive to evidence that the invention met a long-felt need.¹²⁰ In some cases, namely those before British Courts, it is the combination of long-felt need and commercial success that is appreciated as evidence of an inventive activity.¹²¹ The EPO has also

¹¹⁴ T 247/87 *Cracking Composition/Phillips Petroleum*, (Apr. 28, 1988) OJ EPO, 1989, 207. see also T 249/88 *Milk Production/Monsanto*, (Feb. 14, 1989), unpublished

¹¹⁵ T 694/92, OJ 1997, 408. See also T 187/93 or T 923/92 (OJ 1996, 564) all quoted in the EPO (2001) *Case law of the Boards of Appeal of the EPO*, available at <http://www.european-patent-office.org>

¹¹⁶ EPO (2001) *Case law of the Boards of Appeal of the EPO*, p. 119

¹¹⁷ See EPO (2001) *Case law of the Boards of Appeal of the EPO*, p. 119-120 quoting numerous decisions in this sense. See also a decision of a French Court, Lyon, October 6, 1981, *ANNALES*, 1982, 225

¹¹⁸ T 92/86 *Air Drying Apparatus/ Grass-Hair Holding*, unpublished; BASF/ *Triazoles Derivatives*, OJ EPO 1989, 74 See also decisions T 677/91, T 626/96 quoted in EPO (2001) *Case law of the Boards of Appeal of the EPO*, pp. 136-137. See also a decision of the British Chamber of Lord, *Southco Inc v Dzus Fastener Europe Ltd* [1990] RPC 587 at 619

¹¹⁹ T 270/84 *Production of Explosive Fusecord/ICI*, (Sept. 1, 1987) OJ EPO 1987, 357. See also T 478/91

¹²⁰ T 106/84 *Packing Machine* (Feb. 25, 1985), OJ EPO, 1985, 132 ; T 09/82, OJ 1984, 473; T 555/91 and T699/91 unpublished

¹²¹ *Longbottom v. Shaw* [1981] 8 RPC 333, at 336

considered novelty,¹²² unexpected results,¹²³ and surprising or advantageous effect¹²⁴ as evidence of an inventive step. These last indices seem to characterize research results rather than research approaches. Some critics suggest that in so doing the EPO tends to reduce the inventive step requirement to novelty, whereas it should rather be an additional, more demanding condition.¹²⁵ At the very least, one can observe that in some decisions the EPO examines the requirement of inventive step with much indulgence.¹²⁶

3.2.2.2 The Second “Strategy”

The second strategy to adapt intellectual property law to technological change consists in enacting *sui generis* regimes such as utility models,¹²⁷ registered design protection laws,¹²⁸ unregistered designs,¹²⁹ plant

¹²² The EPO considered inventive, new expression plasmids containing marker genes able to identify genetically modified micro-organisms, T 264/87 *Yeast Transformant/Anvar*, unpublished; See also T162/86 *Plasmid pSG2/Hoechst AG*, OJ EPO 1988, 452 and T 0301/87 *Alpha Interferons/Biogen*, OJ EPO, 1990, 356

¹²³ T 249/88 *Milk Production/ Monsanto* (Feb. 14, 1989), unpublished, holding that an unexpected result can establish inventive step.

¹²⁴ T 0301/87 *Alpha Interferons/Biogen*, OJ EPO, 1990, 335

¹²⁵ See Christine Noiville (1997), *Ressources Génétiques et Droit. Essai sur les régimes juridiques des ressources génétiques marines*, Institut du Droit Economique de la Mer, Pedone, Paris, pp. 124-131 or H.-R. Jaenichen (1993), *The European Patent Office Case law on the patentability of Biotechnology Inventions*, Carl Heymans Verlag, Cologne, p. 121 See also EPO case T130/90, §5.4 (where the EPO explicitly confused novelty with inventive step considering that the absence of a correct divulgation of the invention in the prior art as an evidence of an inventive step). and case T 261/89, *Human hepatitis A virus/Merck*, §3.3.2 (March 9, 1990)

¹²⁶ Michel Vivant (2003), *Protéger les inventions de demain (...)*, p. 118

¹²⁷ The prototypical regime was the German Utility Model Act of June 1, 1891 which remained largely unchanged until the Bundesgesetzblatt Act to Amend the Utility Model Act, 1986 I, 1446. Originally, utility patent laws protected the external product configuration or that enhanced the technical proficiency of the tool, they did not protect the underlying idea or process. In 1990 Germany enacted reforms that permitted protection of electronic circuit designs, chemical substances, foodstuff, drugs and immovable. Eligible innovations obtain patent-like protection for a shorter period (from 6 to 10 years) without substantive examination. Whenever the protection is contested in courts, the latter generally apply a weaker standard than non-obviousness and usually take into account factors like commercial success. The scope of protection is narrower than in patent law. Similar laws have long existed in Japan (1905) and Italy (1940), they have a growing success among developing countries and the European Commission is willing to generalize them in all European Union countries: see Proposal for a European Parliament and Council Directive Approximating the Legal Arrangements for the Protection of Inventions by Utility Model.

¹²⁸ After a few attempts to apply the full patent paradigm (U.S. Design Patent Law of 1842) or to protect industrial design by copyright law (several European countries), a *sui generis* regime has been adopted by members of the Paris Convention that was amended in 1958 to require some protection or industrial designs. These design laws protect

breeder's rights,¹³⁰ integrated circuit protection,¹³¹ and databases protection¹³² to deal with technology-specific applications of know-how. Actually, the objective of this second "strategy" is similar. Faced with large economic sectors producing small-scale and easy to copy innovations, governments enacted sector specific legislation. These *sui generis* rights share several characteristics: they consist of exclusive property rights, they mix some modified elements of patent and copyright, and the requirements for protection are much lower than in patent law.¹³³

The danger with both these strategies is that they modify the trade-off between innovation incitement and access to these innovations, usually to the detriment of the latter. In addition, they do not take into account the cumulative and collective dimensions of innovation, which generate unexpected problems that may hinder innovation. I take a closer look at these difficulties in Chapter Four. I will now turn to examine changes in the distribution of research activities between Science and Technology.

those elements incorporated in industrial products that aim to enhance their attractiveness by aesthetic features. Usually, registration, deposit, some objective novelty and some degree of innovation are required. Theoretically, functionally determined designs are excluded, but the frontier between aesthetic and functional design is often a blur. Those laws provide exclusive rights similar to patent law but the duration is usually shorter (10 or 15 years)

¹²⁹ Dissatisfaction with industrial design *sui generis* laws led some countries in the late 1980s to come back to the old solution to protect designs by means of copyrights laws. The practice that still existed in France has been judicially revived in Benelux and in the United States, while in the United Kingdom the Copyright Designs and Patent Act 1988, grants a copyright-like protection for 15 years.

¹³⁰ I will study those rights in details in the second part of this dissertation.

¹³¹ In 1984, United States enacted the Semi-conductor Chip Protection Act (SCPA). It affords short-term (10 years), copyright-like protection to "mask works" i.e. surface images of integrated circuit. Like copyright law, SCPA requires originality and fixation; it does not protect any idea, procedure, and process, and systems, methods of operation, concept, principle or discovery. It protects against copying but not against independent creation. Mask work must be registered and are protected for ten years. Two years later, the European Union Council adopted a Directive 87/54/EEC on the Legal Protection of Semi-conductor Product creating a similar *sui generis* right.

¹³² In 1996, the European Union Parliament and Council adopted a Directive 96/9 on the Legal Protection of Databases. The *sui generis* regimes mandated by this directive confer as strong and potentially perpetual exclusive property right in collection of data and information as such. This regime convert data and information – previously unprotectable raw materials – into the subject matter of a exclusive property right that is paradoxically more powerful in some elements than either the patent or the copyright;

¹³³ Jerome H. Reichman (1994) "Legal Hybrids..."

3.3 Distribution between Open Science and Proprietary Technology

In the last several decades, the economic and legal division between Science and Technology, as well as the norms of science, have been largely affected by a series of changes: a change in the innovation process and a change in the innovation policy. Both of these changes have led to adaptations in patent law and in universities' attitudes towards patenting. To some extent these changes are common to most technical sectors, but it is once again in the biotechnological sector that they appear most strongly.¹³⁴

3.3.1 Changes in the Innovation Process

The relationship between Science and Technology has changed; their common frontier is increasingly blurred. In the 1930s, the important research-based industries were in the chemical and electrical fields. As chemistry and electrical engineering were still young, the findings in these disciplines were quite basic. Therefore, the distance between science and technological application was very large. Important time-lags and investments were necessary before science findings could lead to commercial products. By the 1970s and 1980s, the time-lag between science and technology had collapsed. In important sectors such as biotechnology, the transformation of science findings into commercial products became increasingly shorter. For instance, it only took three years for the Cohen-Boyer findings on recombinant DNA in 1973 to lead to a commercial product and to the creation of an enterprise (Genentech).¹³⁵ Moreover, it has become increasingly difficult to pinpoint research problems into one particular category; rather they transcend traditional categories and straddle several scientific disciplines. Academic and industrial researchers often work on the same problems; scientific discoveries are made in industries and patentable inventions are made in universities. Actually, it would be more exact to delineate research activities into three categories.

¹³⁴ In the context of this dissertation, I focus on patent, but some similar trends could be observed in the copyright field and more precisely in database matters. For more details, see Jerome H. Reichman and Paul F. Uhlir (2003), "A Contractually Reconstructed Research Commons..."

¹³⁵ See the works of Robert Teitelman (1994), *Profits of Science: The American Marriage of Business and Technology*, New York: Basic Books, quoted by Robert P. Merges (1996), « Property Rights Theory and The Commons... », p. 156.

Goal of the research?	A practical invention		
A fundamental understanding		No	Yes
	Yes	Pure basic research (Science)	Basic research inspired by an application
	No		Pure applied research (Technology).

Source: Stoke¹³⁶

The third category, basic research inspired by an application,¹³⁷ seems to have taken on a growing importance. As we shall see *infra*, this type of research is located at the source of challenges in the organization of the innovation process. There is likely a high degree of of tension between the reward system and the norms of behavior of Science and Technology.

This change in innovation process is further increased by a change in the ease of gathering capital for research-intensive industries. For a long time, it was thought that only large corporations could offer long-term oriented basic research. More recently, the capital-markets have been placing value on intellectual property long before a product is ready for the market. Start-up companies based on new scientific findings can acquire capital from firms specializing in such speculative investment. However, there are some important differences between the United States and Europe. Even if things are changing the “start up model” is less widespread in Europe, notably in France where this type of research is still largely carried out by the public sector.¹³⁸ Moreover, it is still more

¹³⁶ D. Stoke (1994), « The Impaired Dialogue Between Science and Government and What Might Be Done About It », *AAAS Science and Technology Policy Yearbook*, Washington DC., quoted by Dominique Foray, (2000), “L’économie de la connaissance”, p. 38

¹³⁷ For an detailed analysis of this type of innovation called « Pasteur like activities » by contrast to “Bohr like activities” (pure basic research) and “Edison like activities” (pure applied research) see Richard R. Nelson & P. Romer (1994), “Science, Economic Growth, and Public Policy”, in B.L. Smith & C.E. Barfield, *Technology, R&D, and the Economy*, The Brookings Institution Press, Washington D.C. pp. 49-74

¹³⁸ For a comparison between the American “start up model” and the French “clinician model” see Maurice Cassier & Jean-Paul Gaudillière (2000), “Les relations entre science, médecine et marché dans le domaine du génome: pratiques d’appropriation et pistes pour de nouvelles régulations: le cas de la génétique du cancer du sein”, Working Paper IMRI, pp. 45-53

difficult to raise funds for early stage technologies in Europe than it is in the United States.¹³⁹

3.3.2 Change in Innovation Policy: the Bayh-Dole Act and Similar Legislation

These changes in the relationship between Science and Technology will be important factors in promoting intellectual property claims in basic research discoveries. However, the most important change probably occurred in 1980 when the American Congress enacted the Patent and Trademark Law Amendments Act. Known as the Bayh-Dole Act, these amendments launched an important change in American innovation policy and the justifications underlying patent law. Traditionally, the justification for patents was that they provide incentive to invent. In the Bayh-Dole Act, the policy objective is not about promoting invention as such, but rather it is to use the patent system to promote the utilization of inventions arising from federally supported research or development.¹⁴⁰

Before the enactment of the Bayh-Dole act, only a handful of American universities were moving science from the laboratory to industrial commercialization. In the 1960s and 1970s, there was much debate surrounding government patent policies. There was no government policy¹⁴¹ regarding the ownership of inventions made by government contractors and grantees under federal funding. The flow of government-funded inventions to the private sectors was very low.¹⁴² The problem was partly due to government reluctance to relinquish ownership of federally funded inventions to the inventing organization. Instead, the government retained titles and made these inventions

¹³⁹ Veronica de Juan (2002), "Comparative Study of Technology Transfer Practices in Europe and the United States", 15 JOURNAL OF THE ASSOCIATION OF UNIVERSITY TECHNOLOGY MANAGERS 31

¹⁴⁰ 35 U.S.C. 200, emphasis added. About the economic justification of the Bayh Dole Act and its critic see Arti K. Rai (1999) "Regulating Scientific Research...". More broadly about the development of "ex post justifications" for intellectual property that focus not on incentive to create new ideas, but on what happens to those ideas after they have been developed see Mark Lemley (2003) "Ex Ante versus Ex Post Justification for Intellectual Property" Working Paper

¹⁴¹ Before 1980, each federal agency sponsoring research (there were 26) had its own policy, more or less restrictive: Rebecca S. Eisenberg (1996) "Public Research and Private Development: Patents and technology transfer in Government Sponsored-Research", 82 VIRGINIA LAW REVIEW 1694

¹⁴² According to U.S. Government Accounting Office Report to the Congressional Committees entitled "Technology Transfer, Administration of the Bayh-Dole Act by Research Universities", May 7 1998, in 1980, the federal government held title to approximately 28,000 patents. Fewer than 5% of these were licensed to industry for development of commercial products.

available only through non-exclusive licenses to anyone who wanted to use them. As a result, firms were less inclined to invest in and develop new products if competitors could also acquire licenses and then manufacture and sell the same products.

The goal of the Bayh-Dole Act¹⁴³ is precisely to overcome this situation and to promote the widespread utilization of publicly funded research. In this sense, it authorizes universities to patent inventions made under federal funding and to become involved in their commercialization. It also permits exclusive licensing when combined with fast development and transfer to the marketplace.¹⁴⁴ In addition, the Bayh-Dole Act requires universities to share patent royalties with inventors so that both universities and individual scientists have incentives to seek patents for their inventions and collaborations with firms ready to invest in the development of their innovations.

The results have been very impressive. In the late 1970s, the number of university patents had increased due to the apparent promise of rapid commercial applications for biological research. In 1979, 264 patents were issued to American universities. After the enactment of the Bayh-Dole Act, many universities set up technology transfer offices (TTO) or revitalized the existing ones and the patenting trend accelerated significantly.¹⁴⁵ By 1997, the total number of patents granted annually to universities had increased to 2,436.¹⁴⁶ This ten-fold increase is much more important than the two-fold increase in overall patenting activity during the same period¹⁴⁷ and largely exceeds growth in university research funding.¹⁴⁸

143 See also Stevenson-Wydler Technology Innovation Act of 1980, Pub. L. No. 96-480, par. 2, 94 Stat. 2311-2320 (1980) (codified as amended at 15 U.S.C. par. 200-212 (1994) that entrusted the federal agency sponsoring research with the responsibility of technological transfer.

144 35 U.S.C. 202

145 Pierrick Malissard, Yves Gingras et Brigitte Gemme (2003), « La commercialisation de la recherche scientifique », LES ACTES DE LA RECHERCHE EN SCIENCE SOCIALE, N°148 (Juin) pp. 57-68

146 Mowery D.C. et al. (2001), « The Growth of the Patenting and Licensing by U.S. Universities : an assessment of the Effects of the Bayh-Dole Act of 1980 », RESEARCH POLICY 99, 104

147 In 1979, a total of 48, 54 utility patents were granted. By 1997, that number had increased to 111,983. Source: U.S. Patent Statistics, Calendar Years, 1963-2000, available at <http://www.upsto.gov/web/offices/ac/ido/oeidp/taf/reports.htm#PSR>.

148 However, it must also be mentioned that despite the increased involvement of the industry with university, industry only funds a small part of university-based research

In Europe, university-industry partnerships are less developed than in the United States, although since the 1980s some measures have been taken to encourage such partnerships.¹⁴⁹

Ironically, Professor Merges observes that the first proposals to protect the results of basic research were launched in Europe. In 1922, a Member of the French Chamber of Deputies and law professor, J. Barthelemy, introduced a detailed bill to overturn the prohibition on patenting “principles, methods systems, discoveries and theoretical or purely scientific conceptions for which no industrial application are indicated.”¹⁵⁰ According to the proposal, a scientist should obtain a “patent of principle” that would confer a right of remuneration but not an exclusive right to make or use a discovery. Anyone would be free to obtain a license to use the discovery, so long as he paid royalties to the discoverer. The duration of protection would have been similar to copyright at that time: the life of the innovator plus fifty years. Similar proposals were made in several other countries and a draft convention was even prepared by a committee of experts at the League of Nations. These proposals were part of a larger post-World War I movement in favor of the “droit de suite” and other “moral rights” for authors and creators. However, the proposal lost momentum and raised objections. These objections included the difficulty to trace the scientific origins of an industrial application, the lag time between the disclosure of the discovery and the development of industrial applications, and above all, the argument that such property rights would be at odds with science’s free and open system of communication. Finally, the idea to protect basic scientific research was defeated.¹⁵¹ Although this proposal was abandoned, it remains interesting as it demonstrates the idea of endowing authors of discoveries with a right of remuneration, i.e. a liability rule (*Cf. infra*) as opposed to an exclusive property right.

Despite the defeat of these proposals, some academic institutions, in engineering in particular, have a long tradition of partnerships with industry and of patenting results of research. It is not the purpose of this dissertation to describe the different situations in the various EU

149 Jeremy Howells & Carole McKinley (1999), *Commercialisation des résultats de la recherche universitaire en Europe*, Rapport final au groupe d’experts sur la commercialisation des résultats de la recherche universitaire du Conseil consultatif (Canadien) des sciences et de la technologie.

150 French Patent Law of 1844

¹⁵¹ For more details on these proposals, see Robert P. Merges (1996), « Property Rights Theory and the Commons... »

member states. However, it can be said that from the 1980s onwards, in light of the reduced time-lag between a discovery and its industrial application, and from keen observation of the situation in the United States, most European states have taken measures to support university patenting and cooperation between academics and industrials. These measures have included the relaxation of legislation prohibiting contacts between universities and firms, legislation promoting the patenting of universities' research results, a general increase of risk-capital, and the creation of technology transfer organizations. Schematically, European countries can be divided in three groups.¹⁵² One group of countries or regions have recently enacted laws, regulations or policies assigning ownership or the first right to ownership to Universities. This is the case for Austria, Belgium (with differences between the three regions¹⁵³), Denmark, France, Spain and Russia. In a second group of countries, there is a system of "professor's privilege" assigning inventions to university professors. This is the case for Finland, Norway and Sweden. Germany had a similar system, which has recently been abolished. In contrast, Italy has enacted a system of professor's privilege. The last group includes countries that have not yet taken a definite policy orientation for university-based technology transfer.

In closer examination of France,¹⁵⁴ for example it is seen that a progressive effort is made to enhance the patenting policy of academic and medical institutions.¹⁵⁵ In 1967 a progressive step was taken with the creation of the agency for the promotion of public research (ANVAR) and another step forward occurred in 1973 with the constitution of the industrial relations committee within the national center for scientific research (CNRS). A further step was made in 1982 when the promotion of public research and its industrial application become an explicit mission of the CNRS. An audit of the early 1990s highlights the small number of patents for which licenses were granted. During the same period a joint subsidiary of ANVAR and CNRS was created for the

¹⁵² Expert Group Report (2004), *Management of Intellectual Property in Publicly-Funded Research Organisations: Towards European Guidelines*, European Commission

¹⁵³ See notably Région wallonne, Décret programme du 17 décembre 1997, portant diverses mesures en matière d'impôts, taxes et redevances, de logement, de recherche, d'environnement, de pouvoirs locaux et de transports, Moniteur belge (M.B.) 27.01.1998

¹⁵⁴ For a detailed analysis of the situation in the United Kingdom, see Richard Lambert (2003) *Review of Business-University Collaboration, Final Report*, available at www.lambertreview.org.uk

¹⁵⁵ Maurice Cassier (2002) "L'appropriation des connaissances dans les partenariats de recherché entre laboratoires publics et entreprises: quelques tendances récentes", Working Paper IMRI p. 41

protection and exploitation of innovations derived from public research, notably by the creation of start-ups. Most notable, a 1999 law on innovation and research¹⁵⁶ has created a general environment that encourages collaboration between Science and Technology; it modifies the statute of public researchers and public research institutions in order to facilitate cooperation with private firms. This law further creates a fiscal and legal framework to favor the creation and development of innovating enterprises. Generally speaking, in France as in other European countries, public authorities have removed obstacles to cooperation with the private sector and have tried to modify the traditional indifference or opposition towards patenting in the academic community. So far, despite the concern of some researchers, the trend toward increased marketing of universities research results has aroused little debate, as the expectations of positive economic effects¹⁵⁷ tend to defuse any opposition. As a result, even if Europe remains a few steps behind the United States, a large increase in the patenting activity of universities is being observed in Europe, especially in life sciences.¹⁵⁸

3.3.3 Changes in Patent Case Law

These two developments –the narrowing of the conceptual gap between fundamental research and commercial application and the Bayh-Dole view that the role of patent is not only to spur invention but also to foster efficient development and commercialization – have led to an upstream shift in patenting activity. This shift has received little opposition from the courts.

In American law, the move can be seen on three fronts: (i) legal scholars criticizing *Brenner v. Manson*, (ii) the Courts, and (iii) the Patent Office. Not all legal scholars have been positive about *Brenner v. Manson* and some have argued that *Brenner's* utility requirement could impede progress in chemistry by discouraging disclosure of new chemical “intermediates” i.e. chemical compounds useful to create other compounds.¹⁵⁹

¹⁵⁶ Loi n° 99-587 du 12 juillet 1999 sur l'innovation et la recherche, J.O. n° 160 du 13 juillet 1999 page 10396

¹⁵⁷ OECD (2000), *A New Economy? The Changing Role of Innovation and Information Technology in Growth*

¹⁵⁸ For example in France, among the 10 most patenting organizations since 1995, 6 are public institutions, and among the 50 most patenting organizations, 16 are public institutions.

¹⁵⁹ See Mirabel (1987), “‘Practical Utility’ is a Useless Concept”, 36 AM.U.L.REV. 811; Cooper (1976), “Patent Problem for Chemical Researchers-- The Utility Requirement

In a series of cases, the Federal Circuit started loosening the utility requirement. The Court found that some upstream inventions demonstrate utility, despite the fact that they are far from commercialization. In *Cross v. Iizuka*,¹⁶⁰ the Federal Circuit held that if a novel compound revealed some apparent pharmacological activity during *in vitro* testing (i.e. outside of a living environment) such activity was sufficient to establish its practical utility. This was sufficient so long as there existed a probability that subsequent *in vivo* testing (i.e. much further downstream in the innovation chain) would be successful.¹⁶¹ Then, in *In re Brana*, the Federal Circuit reversed a decision that rejected claims to novel compounds that were structurally similar to other compounds having an anti-tumor effect on mice. The Court recognized that further research was necessary before the compounds could be administered to humans but held that “Usefulness in patent law, and in particular in the context of pharmaceutical inventions, necessarily includes the expectation of further research and development.”¹⁶²

The U.S. Patent and Trademark Office (USPTO) was also part of this trend towards the loosening of the patentability requirements. One well-known example is the attempt of the National Health Institute (NIH) to obtain patents for gene expressed sequence tags (ESTs). In 1992, the USPTO rejected the claim for lack of utility, particularly because “*although the oligonucleotides embraced by the claims may be hybridized to a variety of different preparations of other nucleic acids, one of skill in the art has no clue as to the significance of any result of such hybridization...*” However a few years later the, USPTO changed its position, stating that ESTs may be patentable.

After *Brenner v. Manson*”, 18 IDEA 23; Eggert (1969), “Uses, New Uses and Chemical Patents—A Proposal”, 51 J.PAT.OFF.SOC’Y 768; Velvel (1967), “A Critique of *Brenner v. Manson*”, 49 J.PAT.OFF.SOC’Y 5; Meyer (1967), “Utility Requirement in the Statute”, 49 J.PAT.OFF.SOC’Y 533; Charles E. Smith (1984) “Comment: Requirement for Patenting Chemical Intermediates: Do they accomplish the Statutory Goals?” 29 ST. LOUIS U. L. J. 191, or Samuel A. Oddi (1989), “Beyond Obviousness: Invention Protection for the Twenty-First Century”, 38 AMERICAN UNIVERSITY LAW REVIEW 1097

¹⁶⁰ *Cross v. Iizuka*, 753 F.2d 1040 (Fed. Circ. 1985)

¹⁶¹ See also *Nelson v. Bowler*, 626 F.2d 853 (C.C.P.A.1980) and Kenneth D. Sibley (1992), “Practical Utility: Evolution Suspended?”, IDEA 203

¹⁶² *In re Brana*, 51 F.3d 1560 (1995) at 1565-69, emphasis added. Compare with the 1966 decision of the Supreme Court on the utility requirement: *Brenner v. Manson* 383 US. 519, 534-5, quoted in chapter 2 (paragraph 2.2.2)

A few months after *In re Brana* the USPTO adopted "Utility Examination Guidelines."¹⁶³ These Guidelines also came after a series of public hearings at which members of the biotech industry stressed that application of an overly restrictive utility requirement discourages investment in the early stage of a company's life by postponing the promise of patent exclusivity for too long. Disregarding the Supreme Court's ruling in *Brenner v. Manson* that patent applicants must demonstrate "substantial utility", the guidelines set up a "credible utility" standard, instructing examiners that "if the applicant has asserted that the claimed invention is useful for any particular purpose (i.e., a specific utility) and that assertion would be considered credible by a person of ordinary skill in the art, do not impose a rejection based on lack of utility". The guidelines did not elaborate on the meaning of "specific utility", seeming to equate specific utility with any particular purpose. Hence, they appear to indicate that if an applicant honestly and credibly asserts any purpose for the invention, even an utterly trivial use, then the examiner could not reject the application for lack of utility.¹⁶⁴ Because all substances can, in theory, serve some purpose, the USPTO's and Courts' benevolence towards patents has promoted imaginative claiming strategies and unprecedented levels of patenting activity. Throughout the course of a single year, the USPTO received 350 gene patent applications claiming more than 500,000 sequences. The patent office estimated that it would take one patent examiner 200 years to examine these applications. In late 1998, the first gene expressed sequence tags (ESTs) patent was granted to Incyte Pharmaceuticals, which at that time had filed application on 1.2 million partial gene fragments.¹⁶⁵

A few years later, however, the USPTO took a step backwards. In December of 1999, the USPTO replaced the 1995 guidelines with the "Revised Interim Utility Examination Guidelines"¹⁶⁶ attempting to clarify the patent office's position on the meaning of the utility requirement. After receiving public comments on the interim guidelines, final guidelines¹⁶⁷ were issued in 2001. Referring explicitly to *Brenner v. Manson*, the 2001 guidelines require not only specific and credible utility but also a substantial assertion of utility: "a claimed invention must have specific and substantial utility". The "Training Material for Examiners" further provides that a "specific utility" is defined as *a utility that is specific to the subject matter claimed. This contrasts with a general utility that would be applicable to the broad class of invention*; while a "substantial utility" is defined as *a utility that defines a "real world" use. Utilities that require or constitute carrying out further research to identify or reasonably confirm a "real world" context of use are not substantial utilities*.¹⁶⁸ The immediate effect of this increased utility

¹⁶³ U.S. Patent and Trademark Office, "Utility Examination Guidelines", 60 Fed. Reg. 36,263 (July 14, 1995)

¹⁶⁴ Robert P. Merges and John F. Duffy (2002), *Patent Law and Policy: Cases and Materials*, Lexis Nexis, Third Edition, p. 248

¹⁶⁵ Linda J. Demaine & Aaron Xavier Fellmeth (2002), "Reinventing the Double Helix: A Novel and Nonobvious Reconceptualization of the Biotechnology Patent" 55 STANFORD LAW REVIEW 303, p. 325-326

¹⁶⁶ U.S. Patent and Trademark Office, "Revised Interim Utility Examination Guidelines", 64 Fed. Reg. 71,440 (December 21, 1999)

¹⁶⁷ U.S. Patent and Trademark Office, "Utility Examination Guidelines", 66. Fed. Reg. 1092 (January 5, 2001)

¹⁶⁸ U.S. Patent and Trademark Office, "Revised Interim Utility Guidelines Training Materials (1999)", available at www.uspto.gov

standard has been to put an end to attempts to patent ESTs. This interpretation of the utility requirement and the refusal to grant patent for ESTs has been challenged in front of the Court of Appeal of the Federal Circuit. In September 2005, in *In Re Fisher*,¹⁶⁹ the Court confirmed the non-patentability of ESTs for lack of utility.

Nevertheless, beyond the controversy over the patentability of ESTs, it is difficult to assess precisely how demanding the patent office and Courts are, and whether the utility requirement still plays a role in mediating the boundary between academic science and commercially valuable applied technology.

In Europe, one can observe, to some extent, a similar evolution. The European situation is more difficult to document as there is no uniform case law in Europe and courts rarely reverse the EPO decisions to grant a patent. However, it can be noted that in the case of biotechnology, (i) the distinction between discovery and invention tends to blur, and (ii) the requirement of industrial applicability is interpreted loosely.

The distinction between a discovery and a patentable invention appears to be particularly difficult to apply in the biotechnological sector. According to the EPO case law, the criterion used to make the distinction is “the importance of the human intervention”.¹⁷⁰ Thus, the invention is realized from the discovery; isolating and revealing a natural substance through a precise description makes it an invention. This evolution is confirmed by Directive 98/44/EC on the legal protection of biotechnological invention that defines the biotechnological invention by two functions: the first function consists of the isolation of a biological material from its environment, and the second function is in the ability

¹⁶⁹ *In re Fisher*, No. 04-1465 (Fed. Cir. September 7, 2005), the real party in interest is Monsanto Technology LLC, which is owned by the Monsanto Company.

¹⁷⁰ See e.g. EPO (Dec. 8, 1994) O.J. EPO 1995, 388.. In this Relaxine case, opponents to the patentability of a DNA fragment codifying a human protein (Relaxine H2) evoked some arguments on the distinction discovery versus invention. In their opinion, admitting the patentability of this DNA fragment would be equivalent to admit the patentability of the Moon discovery in 1969 or the mummy Ötzi discovery in an alpine glacier.). The EPO answered by recalling its case law on natural substances patentability: Finding a substance in nature is a discovery that cannot be patented. However if a new substance is found in nature and if a process allowing access to this substance is developed, the process may be patented. Moreover if this substance can be sufficiently characterized by its structure, it may be patented.

to produce the biological material through a technical process (article 3).¹⁷¹ This leads Professor Michel Vivant¹⁷² to ask whether it would not be better to conceive of the distinction in terms of “continuum” rather than in terms of “separate territories”. The transformation from discovery to invention is reduced to very little. Accordingly, assigning a function to a law of nature, or to a product discovered or revealed, converts their transformation into a patentable invention. It is difficult to know whether the distinction between discovery and invention could have been interpreted in a different way. However, it can be said that as it is interpreted, the distinction cannot draw a boundary between Science (basic research) and Technology (applied R&D).

Regarding the industrial application requirement, it has been loosely interpreted and has not received much attention. The EPO has been reluctant to use the requirement in mediating the boundary between basic research and commercially valuable applied technology. Firstly, the EPO tend to regard industrial applicability as a loose requirement concerning the context in which the invention is used. The EPO considers that an invention can be considered as having an industrial application if it can be made or used in any industry.¹⁷³ So far, this interpretation has been used only to reject the patentability of inventions employed in private and/or personal spheres.¹⁷⁴ Secondly, in the expression “susceptible of application”, the EPO put the emphasis on the word “susceptible” to accept the patentability of inventions whose industrial application is not yet totally known. If the applicant can prove a potential future industrial application rather than an actual one, the industrial application criterion is deemed to be fulfilled.¹⁷⁵ Moreover, it has been observed that in practice, evidence of a potential industrial application is often fabricated by computer analysis, which compares the invention in question with similar known substances, and suggests potential functions, the existence of which may later be confirmed.¹⁷⁶

In sum, the requirement that an invention must be susceptible to industrial application has never had an important function. Indeed, often

¹⁷¹ Directive 98/44 on the Legal Protection of Biotechnological Inventions, O.J. 99/101

¹⁷² Michel Vivant (2003), *Protéger les innovations de demain (...)* p. 46

¹⁷³ In T 144/83 (OJ 1986, 301)

¹⁷⁴ In T 74/93 (OJ 1995, 712)

¹⁷⁵ Michel Vivant, *Protéger les innovations de demain (...)*, p. 61

¹⁷⁶ Henri Feyt (2001), “La protection de la propriété intellectuelle sur le vivant: historique et débats actuels autour des variété végétales », *REVUE OLEAGINEUX, CORPS GRAS, LIPIDES*, n°5 p. 522, quoted by Michel Vivant, *Protéger les innovations de demain (...)*, p. 77

this requirement has been interpreted as being similar to the discovery-invention distinction. Several patent specialists consider that the industrial application criterion functions as a boundary between Science and Technology; however, this interpretation of the requirement has never been widely adopted.

However this conclusion needs to be slightly qualified. Directive 98/44/EC stipulates that the industrial application of gene sequence of partial sequence must be “concretely” exposed in the patent application (article 5, 3°). This statement may appear to be empty but it is generally understood as the European legislator’s rejection of the American Patent Office’s practice at that time of granting patents on sequences without attached functions or with theoretical function not yet proven.¹⁷⁷ At the same time, an Opposition Division of the EPO defined industrial application in the context of gene sequencing with words that were strikingly similar to the wording used in the new USPTO Guidelines: the potential utilization of a sequence disclosed in an application must not be speculative, i.e. it must be “specific, substantial and credible.”¹⁷⁸ Nevertheless, it is difficult to assess with any precision if this apparently demanding interpretation of the industrial applicability requirement will have any effect beyond the controversy over the patentability of ESTs.

In brief, one can wonder whether the discovery-invention distinction and the industrial applicability requirement still play any boundary function between Science and Technology.

In sum, the three-part transformation including (i) the narrowing of the conceptual gap between basic research and commercial application, (ii) the enactment of the Bayh-Dole Act (and similar legislation in European countries), and (iii) the evolution of patent case law, has lead to a dramatic increase in patent-filing by institutions that previously made their discoveries freely available.¹⁷⁹ It is important to understand that this change has two dimensions.¹⁸⁰ First, the types of discoveries that are the

¹⁷⁷ Sven J. Bostyn (2004), *Patenting DNA Sequences (...)*, p. 52

¹⁷⁸ Decision of the Opposition Division of 20 June 2001, ICOS/SmithKline Beecham and Duphar International Research, OJ EPO 6/02, p.293. An appeal has been lodged against this Decision but it is not further pursued.

¹⁷⁹ So far, mainly in the U.S. and in Canada, this move is weaker and less-documented in Europe.

¹⁸⁰ Rebecca S. Eisenberg (2001), “Bargaining over Proprietary Research Tools: Is This Market Failing or Emerging”, in Rochelle Dreyfuss, Diane. L. Zimmermann & Harry. Fist (eds.), *Expanding the Boundaries of Intellectual Property, Innovation Policy for the Knowledge*

subject of proprietary claims have expanded to include upstream discoveries or “research tools”, far removed from product development. In addition to the narrowing of the conceptual gap between basic research and commercial application, the Bayh-Dole Act, and the patentability requirements¹⁸¹ have failed (or refused) to maintain the distinction between downstream inventions that directly lead to commercial application, and research discoveries that enable further scientific investigation. Second, the types of institutions claiming property rights in their discoveries have grown. Universities and non-profit organizations have launched themselves into patenting their research findings. Additionally, in the biotechnological sector one can observe the emergence of commercial biotechnological firms in market niches that lie between fundamental research and end-product development. These firms differ from traditional large pharmaceutical industries. They often have scientists as founders, keep strong scientific and financial ties with universities, and rely on government funding for a part of their research efforts. Some of these firms lack end products and their survival is ensured through the sale of research tools or their personnel’s research capacities to major pharmaceutical firms. So, the domain of proprietary exchange has become more diverse both in terms of objects and participants. The analysis of the American situation demonstrates that this policy has achieved impressive results but that some side effects are also incurred.

In this chapter, I have described how technological changes and changes in governments’ innovation policies have led to legal changes that modify both the distribution of research activities between Technology and Science, and the combination of incentives to produce and share knowledge within both Technology and Science. However, these modifications of the initial two-part balance elicit unexpected difficulties that may hinder innovation. This is the subject matter of the next chapter.

Society, Oxford University Press, New York, p. 226-227, hereafter Rebecca S. Eisenberg (2001), “Bargaining over Proprietary Research Tools...”

¹⁸¹ Particularly the utility requirement in the U.S. and the distinction discovery/invention as well as the industrial applicability requirement in Europe

4. Unexpected Side Effects and New Issues

In the previous chapter, I attempted to describe how intellectual property has been modified to cope with changes both in innovation policy and innovation process. In this chapter, I observe that the evolution of intellectual property law has not been perfectly efficient. I further identify new issues, such as the coordination of knowledge and IPR exchanges in the context of collective and cumulative innovation, as well as the role of social norms and other forms of self-regulation in shaping knowledge exchanges. Then, I explain how intellectual property scholarship attempts to cope with these new issues by integrating several existing theories into intellectual property theory.

4.1 Transaction Costs

4.1.1 Unexpected Problems: Patent Thickets and the Risk of Anticommons

In the first section of the previous chapter, I described how intellectual property law has been adapted to incremental innovation, in order to grant property rights to small-scale innovation. In the second section, I described the tendency towards granting patents on upstream research tools. Thoughtful observers are increasingly noting some side effects that have developed from these adaptations. Where innovation is cumulative and collective, innovators must use a series of patents or obtain a number of licenses in order to innovate and legally bring their new and improved products to the market. In this scenario, seamless IPR licensing transactions become an important condition for innovation; the proliferation of IPRs granted for small-scale innovations and upstream patenting hinders the ease of these transactions and may ultimately forestall new products from reaching the market.

The patenting of small-scale innovations and upstream patents are two elements identified by Michael Heller and Rebecca Eisenberg as the ingredients for a possible anticommons tragedy:

Anticommons can be best understood as the mirror image of commons property. A resource is prone to overuse in a tragedy of the commons when too many owners each have a privilege to use a given resource and no one has the right to exclude another. By contrast, a resource is prone to underuse in a "tragedy of the anticommons" when multiple owners each have a right to exclude others from a scarce resource and no one has an effective privilege of use. In theory in a world of costless transactions, people could always avoid commons or anticommons tragedies by trading their rights. In

*practice, however, avoiding tragedy requires overcoming transactions costs, strategic behaviors, and cognitive biases of participants, with success more likely within close-knit communities than among hostile strangers. Once an anticommons emerges, collecting rights into usable private property is often brutal and slow.*¹⁸²

On its own, the proliferation of exclusive property rights on small-scale innovation (e.g. fragments) is likely to create situations of anticommons or at least thickets of rights that are difficult to break through. Indeed, commercial products (i.e. therapeutic proteins or genetic diagnostic tests) are likely to require the use of multiple small-scale innovations. A firm wanting to develop these products must launch into costly transactions in order to obtain and bundle licenses from the different owners.

This problem is likely to be reinforced by upstream patenting. First, some upstream patents also protect small-scale innovations. More importantly, the value of upstream patents is very difficult to assess because it is uncertain whether or not they will lead to a valuable commercial product. To overcome this risk and valuation problem, the owners relinquish immediate royalties and resort to other types of compensation through so-called 'reach through' or 'grant back' licenses.¹⁸³ *This type of licenses gives the owner of a patented invention, used in upstream stages of research, rights in subsequent downstream discoveries. Such rights may take the form of a royalty on sales that result from use of the upstream research tool, an exclusive or non-exclusive license on future discoveries, or an option to acquire such a license. In principle, they offer advantages to both patent holders and researchers. They permit researchers with limited funds to use patented research tools right away and defer payment until the research yields valuable results.*¹⁸⁴ However, these commitments to extend future licenses create a problem for users of multiple research tools who are faced with similar demands from various other owners.¹⁸⁵ A user cannot promise an exclusive license on future inventions more than once in the course of a research project. Even past promises of non-exclusive licenses conflict with future promises of exclusive-licenses over the same invention. Thus, there is important risk of stacking these overlapping and inconsistent claims on potential downstream inventions. If a particularly valuable invention is highly probable, the developer might be able to reach an agreement with

¹⁸² Michael A. Heller & Rebecca S. Eisenberg (1998), "Can Patents Deter Innovation? The Anticommons in Biomedical Research", 280 SCIENCE 698, p. 699, footnotes omitted

¹⁸³ In some sense, such type of licenses has some connections with the "droit de suite", one of the moral rights of artists in the author right legislation.

¹⁸⁴ Michael A. Heller & Rebecca S. Eisenberg (1998), "Can Patents Deter Innovation?...", p. 701

¹⁸⁵ Rebecca S. Eisenberg (2001), "Bargaining over Proprietary Research Tools...", p. 230

all the rights holders, but if the outcome of the research is more uncertain or has a small potential commercial value, the parties might fail to reach an agreement.

Commenting on the *Report of the National Institutes of Health Working Group on Research Tools*¹⁸⁶, Rebecca Eisenberg identifies four difficulties.¹⁸⁷ First, transaction costs are a greater obstacle to low value exchanges than to high values exchange. Thus, they are more likely to prevent the exchange of research tools than commercial end-products. Second, cultural heterogeneity among institutions in a technical community (e.g. universities, pharmaceutical firms and biotechnological firms) complicate the search for mutually agreed terms of exchange. Third, even within institutions, the interest and the culture of scientists who make and use research tools are different from the interest and culture of lawyers and business people who negotiate the exchange agreements.¹⁸⁸ And fourth, evaluation of research tools and estimation of their possible contribution to potential future inventions is highly speculative and subjective.

If not all observers share the pessimistic view of Heller and Eisenberg, most of them are increasingly expressing concerns that our patent system is in fact creating a patent thicket, i.e. a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology.¹⁸⁹ With cumulative innovation and multiple blocking patents, stronger patent rights can have the perverse effect of stifling, not encouraging, innovation.

Walsh, Arora and Cohen¹⁹⁰ conducted an empirical study in the United States that surveyed actors from university and industry. This study observed that actors generally manage to find their way in this congested landscape. The authors of the study noted several “working solutions”

¹⁸⁶ Report of the National Institutes of Health Working Group on Research Tools Presented to the Advisory Committee to the Director (June 4, 1998), available at <http://www.nih.gov/news/researchtools/index.htm>

¹⁸⁷ Rebecca S. Eisenberg (2001), “Bargaining over Proprietary Research Tools...” p. 231-248.

¹⁸⁸ The second and third point notably are also identified and analyzed in a detailed study of research partnerships in France. See Maurice Cassier (2002) “L’appropriation des connaissances dans les partenariats de recherche entre laboratoires publics et entreprises: quelques tendances récentes”, Working Paper IMRI, 130 p.

¹⁸⁹ Carl Shapiro (2000), “Navigating the Patent Thicket: Cross-Licenses, Patents Pools and Standards Setting”, Working Paper No. CPC00-11, Competition Policy Center, University of California, Berkeley

¹⁹⁰ John P. Walsh, Ashish Arora and Wesley M. Cohen (2002), “The Patenting of Research Tools and Biomedical Innovations”. A summary of this survey has been published in John P. Walsh, Ashish Arora and Wesley M. Cohen (2003), “Working Through the Patent Problem” 299 SCIENCE 1021

that combine taking licenses, inventing around patents, infringement often invoking a research exemption (which does not exist in today's U.S. patent law), developing and using public databases and finally challenging patents and other access restriction in courts. However, if Walsh, Arora and Cohen contest the existence of a total deadlock situation, they acknowledge the increasing cost and delay of negotiating licenses and other access contracts, specifically for universities. Moreover, the authors also observe a reduction in the investigations around a research tool which is exclusively owned by a single actor. In light of the above findings, I conclude that creating situations where exclusive property rights exist but are subsequently ignored by other actors, is not the most stable way to find the right balance between protection and diffusion.

After having briefly described possible problems generated by recent changes in the intellectual property system, I will now turn to examine the economic theory of intellectual property to see how it attempts to deal with these new issues.

4.1.2 A New Issue Theoretical Issue: the Coordination of Knowledge and IPRs Exchanges

In the early stages of IPR economic theory, property rights were assumed to be roughly co-extensive with marketed products. A patent was thought to be a property right over an end-product which had its own economic market. Similarly, a copyright was conceived as a property right over a particular book or picture. In this theoretical context, the discussion was about deciding whether an IPR could be justified: does the benefit of legal incentive to create new works outweigh the reduction of access (deadweight loss)?

This understanding of the economic role of IPRs starts to change as scholars observe the increasing importance of cumulative and collective innovation, and the need for an inventor to obtain permission from several patent holders to use their inventions, and the risk of patent thickets. Subsequently, the economic literature attempts to explain the role of IPRs in facilitating or hindering exchanges of knowledge. The literature does so by integrating into intellectual property theory a basic rule of economic theory: the creation of property rights is a necessary condition for the efficient use of resources; it is not a sufficient condition as **the rights must also be transferable**. Efficiency requires a mechanism by which the owner of a resource can be induced to convey the resource to someone who values it more; a transferable property right is such a mechanism.

The importance of transferable property rights is best seen by way of example. Suppose inventor A makes an invention and obtains a patent. This inventor values the patent at \$10,000 (A's threat value¹⁹¹). Inventor B thinks he could combine his own technology with A's invention and turn the result into a more valuable product. Inventor B estimates that the value to him of obtaining A's patent is \$20,000¹⁹² (B's threat value). Because the potential buyer values the patent more than the potential seller, the sale is possible. The price that the two parties may agree to is likely to be somewhere between \$10,000 and \$20,000 (e.g. \$15,000). Thus, moving a property right from someone who values it less to somebody who values it more creates value. An efficient market requires that the property right be transferred until it ends up in the hands of the person who values it the most. In this example, moving the patent from Inventor A, who values it at \$10,000, to Inventor B, who values it \$20,000, creates a \$10,000 value. Before the transfer, if B had \$3,000 in savings, and the value of the patent to A was \$10,000, the total wealth of A and B combined was \$40,000. After the transfer, their total wealth amounts to \$50,000: \$15,000 (A's money) + \$20,000 (the value of the patent to B) + \$10,000 (the remaining of B's savings) = \$50,000.¹⁹³ Using game theory terminology, we can describe the process of transferring rights as a three steps process. First, the parties must establish their threat values: their respective valuation of the property right (\$10,000 for A and \$20,000 for B). Second they have to determine the cooperative surplus: the value that can be created by transferring the right (B's threat value minus A's threat value). Third, they must agree on the division of the cooperative surplus, and in doing so fix a price.¹⁹⁴

However, if transferring a property right from someone who values it less to somebody who values it more creates wealth, successful bargaining is not always guaranteed. The expression "transaction costs" is used to refer to all the impediments to bargaining. There is no exhaustive and generally agreed upon list of element included in transaction costs, nevertheless, transaction costs can be divided into several large categories.¹⁹⁵ One category, often referred as search costs,

¹⁹¹ The expressions between brackets refer to game theory terminology.

¹⁹² For the sake of simplicity, I assume that B wants to buy the patent rather than negotiate a license that leaves A or third parties using A's patent.

¹⁹³ If they agree on a different price between \$10,000 and \$20,000, the three numbers will change but the total will remain the same.

¹⁹⁴ Robert Cooter and Thomas Ulen (2004), *Law & Economics* (4th ed.), Addison-Wesley, pp. 78-80

¹⁹⁵ *Ibidem*, p. 92

designates the costs of locating an exchange partner; that is to say locating a person who wants to buy what you are selling or sells what you want to buy. Search costs are usually low for standard goods and services and high for unique goods or services. A second category of transaction costs, is the costs of reaching an agreement. These costs are often called bargaining costs. Bargaining costs can be high for a number of reasons. These costs tend to increase as more parties become involved in the negotiation, especially if the parties are dispersed. Bargaining cost can also be high when parties are privately informed. Negotiations tend to be simple when the parties can identify each other's threat value and the cooperative solution. Only once the threat values and cooperative solution are out in the open is the information said to be public; conversely, the information is said to be private when one party knows some of these value and the other does not. Private information complicates negotiations because it must be turned into public information before the parties can identify possible terms for a bargain. The parties may be reluctant to reveal all their private information and may instead act strategically because their share of the cooperative surplus may depend on their ability to keep some information private. Finally, cultural differences or even hostility can also induce bargaining costs. Two additional categories of transaction costs occur when an agreement takes time to fulfill. Monitoring costs designate the cost of observing the behavior of the parties and enforcement costs involve the cost of sanctioning violations of the agreement.

In the real world, transaction costs are never zero; they are lower or higher than the cooperative surplus. If transaction costs are lower, the parties will bargain successfully but their cooperative surplus will be reduced by the amount of transaction costs. If transaction costs are higher than the cooperative surplus, the parties will not bargain successfully, and they will lose the cooperative surplus. This loss of cooperative surplus is also called deadweight loss. Patents thickets are an example of the first scenario and the anti-commons tragedy¹⁹⁶ is an illustration of the second scenario (in that case a cumulative invention will not occur).

¹⁹⁶ Note however that Anticommons is not necessarily a tragedy. First, the resources held in anticommons may be moved to a private property regime by the market if transaction costs are low, or by government intervention (Cf. chapter 5). Second, close-knit groups may over time develop informal norms that help them manage the resource relatively efficiently (Cf. chapter 6). Third, some (rare) resources may be most efficiently held as anticommons. See Michael Heller (1998) "The Tragedy of the Anticommons: Property in the Transition from Marx to Markets", 111 HARVARD LAW REVIEW 621

It is important to further distinguish different issues. In the “discrete innovation model” (*Cf.* section 2.1), the inventor makes a final product. The main issue concerns the relationship between the inventor and the consumer. In this situation, an economic analysis of intellectual property must first undertake a cost-benefit evaluation in an attempt to identify the best trade-off between access and incentives. In other words, the analysis must attempt to identify whether and when the granting of intellectual property rights is justified. The economic function of intellectual property law is to minimize the deadweight loss caused by IPRs.

In the context of collective and cumulative innovation, this issue remains important, but the main problem concerns the relationship between inventors with interdependent patents. The concern of the intellectual property system is to ensure that the patent ends up in the hands of the inventor who values it the most. When transaction costs are high, the market may not be sufficient to ensure an efficient coordination of knowledge and IPRs. To overcome the limits of the market, the law can diminish the cost of bargaining failure (i.e. deadweight loss) by directly allocating the patent to the inventor who values it the most. To some extent, this is the objective of the economic literature on patent scope¹⁹⁷, which is beyond the subject of this dissertation. The law¹⁹⁸ can also encourage private bargaining by reducing transaction costs. In Chapters Five and Six, I examine two bodies of economic literature, the entitlement theory and new-institutional economics. These theories suggest ways in which to reduce transaction costs. In conclusion, one can say that a change in patent law is efficient when it reduces the sum of transaction costs and deadweight losses¹⁹⁹.

¹⁹⁷ See Richard Gilbert and Karl Shapiro, (1990) “Optimum Patent Length and Breadth” 21 RAND JOURNAL OF ECONOMICS 106; Paul Klemperer (1990), “How Broad Should the Scope of Patent Protection Be?”, 21 RAND. J. ECON. 113; Robert P. Merges & Richard R. Nelson (1990), « On the Complex Economics of Patent Scope », 90 COLUM. L. REV., 839; Suzanne Scotchmer (1991), “Standing on the Shoulders of Giants: Cumulative Research and the Patent Law”, 5 JOURNAL OF ECONOMIC PERSPECTIVE 29; J.R. Green and Suzanne Scotchmer (1995), “On the Division of Profit Among in Sequential Innovation”, 26 RAND. J. ECON 20; Howard F. Chang (1995) “Patent Scope, Antitrust Policy and Cumulative Innovation” 26 RAND. J. ECON 34, or Sven J.R. Bostyn (2002), “European Perspective on the Ideal Scope of Protection and the Disclosure Requirement for Biotechnological Inventions in a Harmonised Patent System; The Quest for the Holy Grail?”, 5 JOURNAL OF WORLD INTELLECTUAL PROPERTY 1013

¹⁹⁸ Or economic actors themselves (*Cf.* Chapter 6)

¹⁹⁹ See Robert. C. Ellickson (1993), “Property in Land”, 102 YALE LAW JOURNAL 1315

4.2 Social Norms and Other Forms of Self-Regulation

4.2.1 Unexpected Problems: A Possible Erosion of the Norms of Science

The upstream shift in patenting activity, the entry of patents into the realm of Science, and to some extent the objectives of the Bayh-Dole Act and similar legislations have created a conflict of interest within the norms of science. Adhesion to the norm of open access (“communism” in Merton’s words) remains strong in the community of Science despite the fact that patents are largely available for segments of basic research. One observes, however, an increasing number of scientists departing from this norm, and thus the norm’s effectiveness is threatened. .

Indeed, these trends in patent law aggravate the tension between the norms of science and science’s reward structure. As explained above, the reward system of science grants recognition to the first researcher to make a discovery, thus creating incentives to keep research results out of the hands of research competitors. Traditionally, the incentive to be secretive has been limited by the need to publish in order to gain recognition. Now patent law gives inventors the rights to exclude others from using their research findings in rival or subsequent research, even post-publication. This has modified the balance of incentives and may even undermine Science’s mechanisms to grant free access to new knowledge for further research. However, the concern is larger than the issue of upstream patenting in universities. Scientists face a larger range of appropriation methods other than patents. These include: contracts of access (often exclusive) to upstream genetic material collections, and material transfer agreements (MTA) between firms and universities and between universities and universities, which are now frequently undertaken in order to exchange research materials.²⁰⁰ It is increasingly feared that competitors will seek patents based on research that was “loaned” by another lab. This fear increases the difficulty of obtaining information or research tools on a reasonable or friendly basis.²⁰¹ The

²⁰⁰ Maurice Cassier (2002), “L’appropriation des connaissances dans les partenariats de recherché entre laboratoires public et entreprises: quelques tendances récentes”, Working Paper IMRI, 130 p.

²⁰¹ A recent empirical survey in the U.S. provides some evidences that access to research inputs is increasingly restrictive. Actually, these restrictions might be more problematic for basic research than restricted access to patented material. See John P.

potential value of possible future patents makes the open-access norm less universal and more expensive.

As observed by Professor Merges, even if scientists strongly believe that the norm of open-access (“cooperation” in game theory language) is the correct mode of behavior, they know that their colleagues can be tempted to ignore it because of higher payoffs offered through patenting or restricting access. If scientists find that it is in their self-interest to limit access to their research tools (“defect” in game theory language), they will expect their colleague to do the same. The expectation that others will defect will lead those who strongly adhere to the norm of open access to defect as well, since the worst position is to cooperate when no one else does. For example, this happens where a scientist refuses to patent his research results (or refuses to impose conditions for the use of research tools in a MTA) while all other scientists are patenting their work. The non-patenting scientist would have to pay royalties to all the other scientists in order to access their findings while his own work would be free for anyone to use and he would receive no compensation. Consequently, in game theory language, it can be said that the “equilibrium strategy” is to defect even if all the players would be better off if the cooperative behavior continued. In other words, the problem is that the new reward structure no longer sustains the norm of open-access as there is no way to bind other community member to follow the cooperative arrangement.²⁰²

This unanticipated erosion of norms (or its unanticipated consequences) progressively appears to be a possible obstruction to innovation. Intellectual property scholars have begun to realize the importance of norms as mechanisms for coordinating exchanges of knowledge among scientists. Fortunately, as observed by Professor Rai, this erosion of the norms of science has coincided with American legal scholarship becoming interested in the role of social norms in shaping human behavior.²⁰³

Walsh, Charlen Cho and Wesley M. Cohen (2005) “View from the Bench: Patents and Material Transfer” 309 SCIENCE 2002

²⁰² Robert P. Merges (1996), “Property Rights Theory and The Commons...” pp. 157-158

²⁰³ Arti K. Rai (1999), “Regulating Scientific Research...”, p. 78

4.2.2 A New Issue for IPRs & Economic Theory: the Role of Social Norms and Self Regulation

To deal with the role of social norms in knowledge exchanges, some intellectual property scholars turn to the law-and-norms theory, initiated by Robert C. Ellickson. This theory analyzes the interaction between positive law and social norms in ruling human behavior²⁰⁴ and new-institutional economics, a closely related branch of economic theory that focuses on the role of institutions in facilitating cooperative behaviors.

Norms are rules that emerge spontaneously. They have a social (bottom-up) origin defined by two ingredients: a practice (“what people do”) and a sense of obligation.

Norms differ from law not only by their conditions of emergence but also by their mechanism of enforcement. While violations of the law are monitored and punished by state actors, enforcement of social norms is decentralized and ensured by private actors (peer supervision). Sanctions imposed on norms violators range from informal gossip to exclusion from the group, ruled by the norms. Compliance with norms is not only insured by sanction but is also insured by reward, like the priority rule described above.

Enforcement is one of the main weaknesses of social norms. First, if enforcement is left to the private initiative of individual members of a group, the level of enforcement is likely to be suboptimal. Indeed, monitoring and punishment are public goods; they are costly to the punisher while the benefits are diffusely distributed among all participants.²⁰⁵ Second, norms are subject to **internal defection** in the sense that legal or technological changes can modify the incentives to comply with the provisions of social norms and induce members to disregard the norms. Third, norms can also suffer from **external defection**, in the sense that third parties not subject to the norms of the

²⁰⁴ Robert C. Ellickson (1990), *Order without Law, How Neighbors Settle Their Disputes*, Harvard University Press, Cambridge Massachusetts, London, England, hereafter Robert C. Ellickson (1990), *Order without Law (...)*. See also Eric A. Posner (2000) *Law and Social Norms*, Harvard University Press, Cambridge Massachusetts, London, England

²⁰⁵ Elinor Ostrom (1990), *Governing the Commons. The Evolution of Institutions for Collective Action*, Cambridge University Press, hereafter Elinor Ostrom (1990), *Governing the Commons (...)*, p. 45 or Francesco Parisi (1999) “Spontaneous Emergence of Law: Customary Law” in Boudewijn Bouckaert and Gerrit De Geest (eds.) *Encyclopedia of Law & Economics*, <http://encyclo.findlaw.com/>

group may behave in contradiction with the norms and in so doing influence its effect.

From the standpoint of intellectual property scholarship, it is worth examining what role social norms can play in the coordination of exchanges of knowledge and IPRs.²⁰⁶ Indeed, the “Law and Norms” literature and new institutional economics have observed how social norms can act as an alternative to law in order to overcome problems of collective action. They can also play a role in reducing transaction costs. Social norms can take the form of agreed upon lower cost forms of measurement (e.g. standardized weight and measures) or make enforcement effective by specific monitoring or sanctioning devices²⁰⁷. In Chapter six, I examine how social norms and other forms of self-regulation can help coordinate exchanges of knowledge and IPRs.

²⁰⁶ Arti K. Rai (1999), “Regulating Scientific Research...” p. 78. See also Douglas C. North (1990), *Institutions, Institutional Changes and Economic Performance*, Cambridge University Press, p. 41, hereafter Douglas C. North (1990), *Institutions, Institutional Changes and Economic Performance*

²⁰⁷ Douglas C. North (1990), *Institutions, Institutional Changes and Economic Performance*, p.41

5. First Element of Solution: How Rights are Protected?

In Chapter Two I explained how the first stage of economic analysis of intellectual property law examines whether the creation of IPRs are worthwhile. In Chapter Three, I described the increasingly cumulative and collective dimension of innovation and the proliferation of IPRs, which require a growing number of transactions among IPRs holders. In Chapter Four, I examined the anti-commons literature that focuses on risks of transaction failures. Now I turn to discuss the legal entitlements literature, which focuses on the question of *how* rights are protected rather than *whether* they are protected. This analytical framework helps one to understand the relationship between intellectual property rights and IPR transacting (licensing). The entitlement literature originates with the work of Ronald Coase.²⁰⁸ Coase was interested in seeing that rights end up in the hands of the person who most values them. He began asking who should hold an entitlement. He first observed that in the absence of transaction costs, the identity of the initial rights holder is irrelevant (in terms of efficiency), as parties will bargain to an efficient outcome. He also observed that situations where there are no or weak transaction costs are quite rare, and that in presence of transaction costs, initial entitlements do matter. Following Coase, scholars have asked not only who should receive the initial entitlement, but also how this entitlement should be protected. That is precisely what the entitlement literature examines.

5.1 Entitlement Theory: Property Rules and Liability Rules

In order to understand how intellectual property law affects inventors who must acquire access to multiple IPRs before introducing a product to market, some scholars²⁰⁹ have turned to entitlement theory, a body of literature not usually associated with intellectual property.

²⁰⁸ Ronald Coase (1960), "The Problem of Social Cost", JOURNAL OF LAW AND ECONOMICS, vol. 3, October, p. 1-44

²⁰⁹ The most interested is probably Jerome Reichman, see notably Jerome H. Reichman (1994), "Legal Hybrids..." and Jerome H. Reichman (2000), "Of Green Tulips..."

The expression “entitlement theory” actually refers to the framework for legal analysis set up in a well-known paper by Guido Calabresi and A. Douglas Melamed.²¹⁰ In this framework, Calabresi and Melamed attempt to integrate various legal relationships which are traditionally analyzed in separate subject areas, such as property law, contracts law and tort law, by articulating a concept of “entitlement”. The “entitlement” is protected either by a property rule, a liability rule or an inalienability rule. For Calabresi and Melamed, the first issue any legal system must face is what they call the problem of “entitlement”. Whenever two or more people (or groups of people) have conflicting interests, the government must decide which side to favor; law decides who is entitled to prevail. Without government intervention, access to goods and services would be decided on the basis of “might makes right.” For the present purposes, there is no need to dwell on this first issue, the interesting insight lies in the second issue. The state not only has to decide whom to entitle, it must also decide the manner in which entitlements are protected, and whether an individual is allowed to sell that entitlement. Calabresi and Melamed identify three types of entitlements:

- (1) -entitlements protected by a property rule to the extent that someone who wishes to remove the entitlement from its holder must buy it from him in a voluntary transaction in which the value of the entitlement is agreed upon by the seller.
- (2) -entitlements protected by a liability rule whenever some one takes (destroys) the initial entitlement, he must be willing to pay an objectively determined value for it.
- (3) -entitlements inalienable to the extent that their transfer is not permitted between a willing buyer and a willing seller.

The three categories imply different levels of government intervention. Property rules are the form of entitlements that require the least amount of intervention; they imply a decision as to whom to entitle but not as to the value of the entitlement. Liability rules imply an additional stage of government intervention; the value of the entitlement is determined collectively (by the government or some organ, i.e. judges) and not by the parties themselves. Whenever an entitlement is inalienable, government intervention goes one step further: it must decide whom to entitle, determine the compensation to be paid if the entitlement is taken or destroyed, and in some or all circumstances, also forbid its sale

²¹⁰ Guido Calabresi & A. Douglas Melamed (1972), “Property rules, Liability rules, and Inalienability: One View of the Cathedral”, 85 HARVARD LAW REVIEW 1089

In their framework, Calabresi and Melamed attempt to identify the circumstances in which the different types of entitlement are most appropriate, according to two criteria: economic efficiency and distributional goals. In the context of this dissertation, I will only refer to the distinction between property rules and liability rules in terms of economic efficiency. To illustrate their typology, Calabresi and Melamed use the example of the government's eminent domain to take property so long as it pays just compensation.²¹¹ They imagine a situation where a town plans to create a public park at the edge of the city. One thousand owners, in 1000 identical parcels each valued at \$8,000, own the tract of land where the park could be created. It is assumed that the park would benefit 100,000 citizens to the extent that they would each be willing to pay an average of \$100 to have the park. On this assumption, the creation of the park seems desirable: the aggregate value of the parcels for their owners is \$8,000,000 (owners' threat value)²¹² and the value of the park for the citizens is \$1,000,000 (citizens' threat value). Yet, the park might not be created. On the selling side, if enough owners hold-out for more than \$10,000 to obtain a share of the \$2,000,000 (bargaining surplus) that the buyers are ready to pay over the value attached by sellers, the price demanded will be more than \$10,000,000 and the park will not be created. Similarly, on the buying side, some citizens might attempt to free-ride and say that they only value the park \$50, or even nothing, hoping that others will admit a higher value and will make up the \$8,000,000 price.²¹³ The authors conclude that in such situations, where despite the transfer of the entitlement would benefit all the parties, the cost of establishing the value of an initial entitlement is so great that it does not take place; as such it would be better to have recourse to a liability rule and collective valuation. In the context of this particular example, the law actually does use a collective valuation technique in its resort to eminent domain. In this case, society organizes a collective valuation and put a compulsory purchase order, or expropriation, on the parcels of land (the holdout problem is solved). In the same way, society values collectively each citizen's desire of a park and charges him with a taxes based on this value (the free-rider problem is solved). If the total

²¹¹ *Ibidem*, pp. 1106-1108

²¹² The expressions between brackets refer to game theory terminology.

²¹³ If the individual parcel had no or little value separately, this example can be regarded as a spatial anticommons. Michael Heller distinguishes spatial anticommons from legal anticommons: *In a spatial anticommons, an owner may have a relatively standard bundle of rights, but too little space for ordinary use. By contrast, in a legal anticommons, substandard bundles of rights are allocated to competing owners in a normal amount of space (...)*. Michael Heller (1998) "The Tragedy of the Anticommons: Property in the Transition from Marx to Markets", 111 HARVARD LAW REVIEW 621, at 651. The proliferation of patents on interdependent inventions may create a "spatial anticommons".

amount of taxes is higher than the sum of the compensation paid to parcels owners, the park will be created.

Eminent domain is only one example of situations where society can convert a property rule into a liability rule. In their paper, Calabresi and Melamed also examine pollution and criminal sanctions for crimes against property and bodily integrity, though they argue that their framework may be applied in many different ways for different areas of law. The Calabresi-Melamed framework can be adapted to intellectual property; firms wanting to produce new products must first obtain permission from dozens of patent holders.

The example can be rephrased in general terms. The parties (bilateral valuation) are likely to find an agreement in what game theorists call “common knowledge” situations, that is to say when the parties can easily identify their mutual threat value and their possible cooperative surplus.²¹⁴ In these situations, information is said to be public. Conversely, information is “private” when one party knows some of these values and the other party does not. Situations where all the parties do not hold complete information are referred to as information asymmetries. Negotiations tend to be more difficult when information about threat values and cooperative surplus is private. Private information hinders bargaining because it must be made public before the parties can evaluate reasonable terms for cooperation.²¹⁵ Parties may be willing to share part of their private information; but they may want to retain some of their information, as their part of the cooperative surplus depends to some extent on keeping information private. Bargaining may be even more complicated by cultural differences, lack of thrust or increased number of parties involved. In these situations, it is worth considering the option of a liability rule: (1) suppressing the need to obtain the consent of the right holder and (2) transition from bilateral valuation to collective valuation.

Why not then convert all property rules into liability rules? Liability rules also have real problems, including issues with collective valuation. Collective valuation is costly to organize and it may be difficult or impossible to carry out. Moreover, collective valuation represents only an approximation of the value. It is an attempt to determine an

²¹⁴ In this case, threat values are the lowest price the seller is ready to accept and the highest price the buyer is ready to pay; the cooperative surplus is the difference between the two threat values.

²¹⁵ Robert Cooter and Thomas Ulen (2004), *Law and Economics*, Fourth Edition, Addison-Wesley, p. 92

“objective” value of the good; it does not take into account the owner’s “subjective” value of the good. In the example of eminent domain, different owners of similar parcels of land may value their property differently for subjective reasons, such as sentimental attachment. Thus, collective valuation, even when possible and inexpensive, always implies a risk of under or over compensation.

In sum, property rules can be defined as “absolute permission rules:”²¹⁶ one cannot take the entitlement without prior permission of the holder who sets the price. The adoption of property rules is recommended by the following factors: few parties, difficult valuation problems and otherwise low transaction costs.²¹⁷ Liability rules can be defined as “take now pay later rules”: third parties are allowed to use the entitlement without permission of the rights holder so long as they adequately compensate him later. Liability rule have three main characteristics: (1) the suppression of the need to obtain the consent of the rights holder in order to access the protected knowledge, 2) a principle of *ex post* compensation, and (3) a mechanism of collective valuation that replaces bilateral negotiations. In terms of transaction costs, liability rules are especially useful to overcome one category of costs: bargaining costs.

5.2 Application to Intellectual Property Law: Compulsory Licenses

As in the case of eminent domain, when one looks at IPRs in a transactional perspective, the objective of intellectual property law is to summarily place the rights in the hands of the party who values them most. This is one of the policy objectives that justify compulsory licenses, government imposed qualifications on IPRs.

Compulsory licensing enables a government to license to a company, a government agency, or another party the right to use an IPR protected asset without the titleholder’s consent. A competent authority must grant a compulsory license to a designated person, who typically must compensate the titleholder through payment of remuneration. Compulsory licenses do not deny patent holders the right to act against

²¹⁶ The expressions between quotation marks come from Robert P. Merges (1996), “Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations” 84 CALIFORNIA LAW REVIEW 1293; hereafter Robert P. Merges (1996), “Contracting into Liability Rules...”

²¹⁷ Robert P. Merges, (1994), “Of Property Rules, Coase, and Intellectual Property”, 94, COLUMBIA LAW REVIEW 2655

non-licensed parties. Thus, compulsory licenses are liability rules, as described by Calabresi and Melamed.

In patent law, compulsory licenses are granted on an *ad hoc* basis. That is to say, compulsory licenses concern individual patents (or small groups of interrelated patents), and are due to solve well-identified problems, and specific judicial or administrative processes examine the pertinence of their grant. Consequently, in patent law, there is no general liability rule; the patent system lies on property rules and in some circumstances a specific patent may be turned into a liability rule. With some divergences, European legislation, and that of numerous other countries, allows the granting of compulsory licenses in four principal circumstances.²¹⁸ First, it is not be permissible to use the exclusive right of a patent to hinder the development of new technologies. Second, a patent is not a pretext for precluding the exploitation of a technology. Third, in some situations, states require the patentee to produce the invention within their territory. In the case of a refusal by the patent holder, states may grant a compulsory license to a local producer. Four, the state might grant itself a compulsory license for “government use” or for general interest purposes. American patent law does not provide for compulsory licenses, but they are allowed under special legislation as well as antitrust law.²¹⁹

The increasing cumulative dimension of the innovation process confers a new importance on the first two motives for granting compulsory licenses: “dependent” patents, and “patents suppression.”²²⁰ A dependent or improvement patent is a patent which cannot be developed without falling within the scope of another patent, usually referred to as the dominant patent.²²¹ This means that the holder of the

²¹⁸ William Cornish & David Llewellyn (2003), *Intellectual Property (...)*, p. 288-296

²¹⁹ The United States largely resorts to compulsory licensing, though it is little-known, and despite their reluctance during international negotiations to loosen the conditions for granting compulsory licenses. See Jerome H. Reichman and Catherine Hasenzahl (2003) *Non-Voluntary Licensing of Patented Inventions: Historical Perspective, Legal Framework under TRIPS, and an Overview of the Practice in Canada and the United States of America*, UNCTAD/ICTSD Capacity Building Project on Intellectual Property Rights and Sustainable Development (Issue Paper No. 5)

²²⁰ See the UK Royal Society (2003) *Keeping Science open: the effects of intellectual property policy on the conduct of science*, p. 10, recommending that “governments further facilitate compulsory licensing and application of competition law in situations where single or multiple patents do, on balance, unreasonably affect use and development of inventions.”

²²¹ Marie Angèle Hermitte and Benoit P. Joly (1990), *Les relations entre l'évolution de la propriété intellectuelle et l'accès aux ressources génétiques et aux technologies*, Genève ONU ; Marie Angèle Hermitte and Benoit P. Joly (1991), « Plant Biotechnology and Patent in Europe : An economic Analysis of Alternative Intellectual Property Rights Models », 1

dependent patent must obtain consent from the dominant patent holder to work his invention. Thus, a typical situation of holdout risk is created. Patent suppression is part of a broader phenomena generally referred as “strategic patenting.” Where an invention is thought to be so efficient that it may change the future course of an entire industry, an inventor may patent the invention in order to prevent its use by others. This situation is referred to as “patent suppression”, and the objective of the patentee is to prevent the emergence of a new technology.²²² Another aspect of strategic patenting lies in “defensive patenting.” Traditionally it is thought that firms seek patents to recapture their fixed R&D costs. In “defensive patenting” a firm will apply for a patent because it wants to prevent its competitors from obtaining a patent that would otherwise prevent them from using their own innovation and force them to incur licensing fees in order to use it.²²³ In these situations, the objective of legislation on compulsory licenses (liability rules) consists in transferring the power of deciding to grant or refuse a license from the rights holder to a judicial or administrative body.

Despite the provisions for compulsory licenses in many national laws, relatively few compulsory licenses have been granted. This is probably due to highly cumbersome procedures.²²⁴ Commentators have agreed

INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT BIOTECHNOLOGY REVIEW 76; Suzanne Scotchmer (1991), "Standing on the Shoulders of Giant: Cumulative Research and the Patent Law", 5 JOURNAL OF ECONOMIC PERSPECTIVE 29

²²² Landes & Posner (2003), *The Economic structure of IP law* (...), pp.320-321 and Kurt M. Saunders (2002), "Patent Nonuse and the Role of Public Interest as a Deterrent to Technology Suppression", 15 HARVARD JOURNAL OF LAW AND TECHNOLOGY 389

²²³ The figures of an American survey suggest the importance of defensive patenting : according to the survey, "at any given time, over about 95 percent of patents are unlicensed and over about 97 percent are generating no royalties" in Samson Vermont (2002) "The Economics of Patent Litigation", in Bruce Berman (ed.) *From ideas to Assets: Investing Wisely in Intellectual Property* at 327, 332

²²⁴ Simplifications of these complex procedures are not likely to occur as article 31 of the TRIPs Agreement imposes a multitude of conditions for the grant of a compulsory license. Each instance has to be considered individually, and must be preceded by attempts of voluntary negotiation. The scope and duration of the license must be limited to its purpose and must be open to review when circumstances change. The license must be non-exclusive, non assignable and predominately for the supply of the domestic market. Adequate remuneration must be required. Finally, any decision, whether authorized or remunerated, must be open to judicial review. Additional conditions are needed where a "head" or "dominant" patent is being licensed in order to permit exploitation of a "subsidiary" or "dependant" patent: the dependant patent must involve an important technical advance of considerable economic significance in relation to the invention claimed in the first patent; the owner of the first

that the mere authority to grant compulsory licenses, might promote some degree of competition: *the practical value of the existence of compulsory licenses provision in patent law is that the threat of it usually induces the grant of contractual licenses on reasonable terms, and thus the objective of actually working the invention is accomplished.*²²⁵ Nevertheless, it is not certain that compulsory licenses will be the solution to the difficulties raised by cumulative innovation.²²⁶

Compulsory licenses in copyright law are different from those in patent, and are often called statutory licenses. While compulsory licenses for patents are granted for individual patents through a judicial or administrative procedure, compulsory licenses in copyright are generally legislative liability rules, i.e. standard compulsory licenses concerning broad categories of copyrighted works. Whereas a primary concern of compulsory licensing in patent law is overcoming the veto right of the patent holder, the primary concern of compulsory licensing in copyright law is enforcement and standard contracting. One of the oldest and clearest examples of copyright statutory licenses is the mechanical compulsory license in the United States.^{227&228} The history begins in 1908 with a Supreme Court decision, *White-Smith Music Publishing and co v. Appolo and co*²²⁹ which ruled that player piano rolls²³⁰ are not copyrightable. The United States Congress reacted by recognizing that recording and mechanical reproduction rights are a part of copyright. The 1909 Act submits this right to a particular regime; any manufacturer of recordings and other mechanical reproductions can use any musical record without prior consent from the holder of the copyrighted work. There are only two requirements, (1) the work must already have been licensed for mechanical reproduction, and (2) the manufacturer of the mechanical reproduction has to pay statutory compensation to the

patent must be entitled to a cross-license; and the use authorized in respect of the first patent shall be non-assignable except with the assignment of the second patent.

²²⁵ Stephen Ladas (1975), *Patents, Trademarks, and Related Rights*. National and International Protection, Cambridge, p. 427

²²⁶ For an analysis of the pros and cons of compulsory licenses in the biotechnological sector see Sven J. Bostyn (2004), *Patenting DNA Sequences (...)*, pp. 91-104

²²⁷ For a detailed examination of this example, see Robert P. Merges (1996), "Contracting into Liability Rules..." and Robert P. Merges (1994), « Of Property Rules, Coase and Intellectual Property », 94 COLUMBIA LAW REVIEW 2664.

²²⁸ There are other cases of non-voluntary licenses in copyright where the decision to turn a property rule into a liability rule has been taken by rights holders themselves and not by the state (*cf. infra*).

²²⁹ 209 U.S. 1 (1908)

²³⁰ Piano rolls are perforated or punched cards used to enable mechanical pianos to play a piece of music.

copyright holder. The adoption of this liability rule is seen as a compromise between the two extremes: a property rule on the one end, and no rights at all on the other. The immediate effect was an increase in competition: before 1908 the market was dominated by one company, after the Act hundreds of competitors appeared on the market. This first case has been followed by a long series of legislatively mandated compulsory licenses, namely on musical public performances, books and CD rental rights, etc. The multiplication of such regimes in copyright law is due to the importance of transaction costs related to the exploitation of copyright, especially the cost of identifying the rights holder (search cost), the costs of monitoring uses of the protected work and the costs of enforcing rights against infringers. In such legislated compulsory licenses, the copyright property rule is replaced by a standard contract or liability rule which saves bargaining costs. Additionally, this type of compulsory license is often equipped with administrative support that saves the parties the costs of record keeping, payment collection and royalty disbursement (search and monitoring costs). In the field of copyright, the importance of transaction costs has further increased with the development of cumulative technologies such as multimedia. Multimedia works heavily rely on a multitude of inputs generally covered by IPRs, most often copyrights. The transaction costs associated with IPRs consume a lot of resources within the multimedia industry. It is thought that some products are not brought to market for the very reason that they are too expensive to assemble. Consequently, there is an urgent need to find a device to lower transaction costs. Among the policy proposals, several voices call for the adoption of compulsory licenses.²³¹

Finally, compulsory licenses are not limited to patent and copyright law; they can also be used for other IPRs or between different types of IPRs. The European Directive 98/44/EC on the legal protection of biotechnological inventions organizes a system of dependent licenses between a patent and a plant breeders' right.

5.3 The Limits of Compulsory Licenses

One of the main features of the Calabresi and Melamed framework lies in collective valuation. According to the thrust of Calabresi and

²³¹ See for instance Lawrence Lessig (2001) *The Future of Ideas*, New York :Vintage Book outlining a plan for compulsory licensing of copyrighted works, where music and movies publishers should allow anyone to download and use of digital works as long as they pays to copyright holders a fee fixed by statute.

Melamed's framework, courts do collective valuation. In IPRs and compulsory licensing there are two kinds of collective valuation: legislative valuation and judicial evaluation.²³² Both types of valuation have serious limits.

Legislative liability rules, mainly used in copyright, suffer from two defaults. First, the valuation is far from perfect. Legislators have little information about the value of individual IPRs. They have to take their information from group interests; however, as is common across disciplines, some groups may have more influence in the political arena than others. This may or may not be proportionate to their economic leverage in the market.²³³ Moreover, legislators have to resort to gross average evaluation, and do not take into account the sectoral differences. Second, once established, royalty rates are fixed and inflexible. The heavy legislative procedures needed to change royalty rates or to dislodge an unnecessary statutory license are so burdensome that the system is often not able to ensure a responsive valuation system.

Judicial (or administrative) compulsory licenses are mainly used in the field of patents to solve blocking patents and other holdout situations. The risk of bargaining breakdown in pioneer-improver negotiations is high and judicial liability rules may prevent the deadweight loss to which such breakdowns lead. Judicial valuation might be more tailored and flexible than legislative valuation. Indeed, by definition, courts work case- by- case and if judges have little knowledge on the value of the patented invention, they can rely on the parties and possibly independent experts. However, judicial liability rules are afflicted by two shortcomings. First, as mentioned above, procedures to obtain a compulsory license are so cumbersome that, so far, they have never procured a viable solution. Second, if judicial compulsory licensing or the simple threat of them can help to overcome bargaining breakdown between two patent holders, the types of transactions costs are very different from the costs of market transactions where multiple IPRs are needed as inputs.²³⁴ The multiplication of products using a large number of IPRs as inputs imposes repeated costs of locating rights holders and valuating each unique IPR input. Litigation is costly and courts are ill-equipped to treat high volumes of transactions. Litigation would become

²³² Or an individual administrative decision.

²³³ For an analysis of the political economy of intellectual property law see notably the last chapter of William M. Landes & Richard A. Posner (2003), *The Economic Structure of IP Law* (...)

²³⁴ Robert P. Merges (1996), "Contracting into Liability Rules ..." at 1316

frequent due to the valuation problem and costs would extend the list of existing transaction costs.

Consequently, it appears that legislative and judicial collective valuations have some shortcomings. Calabresi and Melamed's analytical framework only envisages two options: either the legislature issues property rules or it establishes a liability rule with a collective evaluation. In the spirit of the authors, they only consider legislative or judicial valuation; they do not discuss other types of collective valuation.

In addition to valuation difficulties, liability rules suffer from a second limitation. Liability rules on their own only address one category of transaction costs: bargaining costs. They do not deal with search costs, monitoring costs or enforcement costs.

To complete the Calabresi and Melamed analytical framework, I will follow the suggestion of Professor Robert Merges.²³⁵ I will now turn to examine another dimension of intellectual property law, "collective rights organizations", and I will highlight another body of literature, "New Institutionalism".

²³⁵ *Ibidem*

6. A Second Solution: Individuals Can Modify their Initial Entitlements

In Chapter Four, I observed that in a context of cumulative and collective innovation with a proliferation of property rights, the coordination of IPRs and knowledge exchanges becomes a major issue. High transaction costs hinder this coordination and hamper innovation. In the case of high transaction costs, where the market does not sufficiently ensure an efficient coordination of property rights exchanges, two solutions are typically considered. Either government (the law) diminishes the cost of bargaining failure (i.e. deadweight loss) by directly allocating the property right to the agent who values it the most, or, government (the law) encourages private bargaining by reducing transaction costs.

In Chapter Five, I examined the entitlement literature, which suggests that government (or courts) can reduce transaction costs by resorting to liability rules (compulsory licenses). The entitlements literature focuses on the issue of strategic bargaining (holdout and free riding) and suggests an interesting instrument (liability rules) to lower one category of transaction costs, i.e. bargaining costs. In so doing, it assumes that government is omniscient and the only actor in the design of transaction patterns. Economic agents must hope that the government is sufficiently inspired in the grant of entitlements, as they are unable to modify the pattern of post-grant transactions.²³⁶

In this chapter, I look at alternative forms of coordination, other than market or government intervention, which I will refer to as 'self-regulation' defined by (i) having some degree of collective constraint, other than that directly emanating from government, (ii) in order to engender outcomes (iii) which would not be reached by individual market behavior alone.²³⁷ In exploring the capacity of economic agents to self-regulate and resort to coordination mechanisms more complex than the market when transaction costs are high, I follow Professor Merges' suggestion²³⁸ towards the new institutional economics literature.

²³⁶ See Robert C. Ellickson (1991), *Order without Law (...)*, p. 138, criticizing the legal-centralism of law and economics scholars.

²³⁷ Julia Black (1996) "Constitutionalising Self-Regulation", 59 MODERN LAW REVIEW, 24-55

²³⁸ Robert P. Merges (1996) "Contracting into Liability Rules..."

6.1 Self-Regulation and the New Institutional Economics Literature

New institutional economics (NIE) is an interdisciplinary enterprise combining economics, law, organization theory, political science, sociology and anthropology in order to explain what institutions are, what function they fulfill, how they arise, how they change and how they can be reformed.²³⁹ NIE concentrates on the coordination between economic agents. Behind the central principle of coordination lie two concepts: transactions and institutions.

Transactions are the mechanisms of economic exchanges; they are roughly equivalent to the legal notion of contract. One contribution of the NIE has been the development of an analytical framework for describing transactions. It attempts to explain the role of institutions and their evolution by giving a central role to transaction costs in their explanation. NIE uses transaction pattern to positively explain why different institutions result in differing levels of economic performance but can also normatively prescribe certain institutional solutions as being more efficient than others.

Although there is no single universally accepted set of definitions, all new-institutionalists distinguish between the institutional environment and institutional arrangements. The institutional environment designates the 'rules of the game', that guide individuals' behavior. They can be both formal, explicit rules (constitutions, laws, property rights) and informal, often implicit rules (social conventions, norms). Among NIE, several groups of scholars focus on different levels of analysis. Douglas North²⁴⁰ and his followers have mainly worked at this macro level, examining the institutional environment and the mutual influence between it and economic agents. To some extent, what I have said in previous chapters on the creation of property rights, or government intervention to overcome bargaining failure in replacing property rules by liability rules, can be associated with this level of analysis.

By contrast, institutional arrangements are specific guidelines designed by economic agents to coordinate particular exchanges.²⁴¹ Oliver

²³⁹ Peter G. Klein (1999) "New Institutional Economics" in Boudewijn Bouckaert and Gerrit De Geest (eds.) *Encyclopedia of Law & Economics*, <http://encyclo.findlaw.com/>

²⁴⁰ See Douglas C. North (1990), *Institutions, Institutional Change and Economic Performance*, Cambridge: Cambridge University Press

²⁴¹ Peter G. Klein (1999) "New Institutional Economics" in Boudewijn Bouckaert and Gerrit De Geest (eds.) *Encyclopedia of Law & Economics*, <http://encyclo.findlaw.com/>

Williamson's work²⁴² focuses on this micro-level, examining how economic agents choose between different coordination mechanisms such as market, hierarchies (e.g. business firm, public bureaucracy or non-profit organization) or hybrid institutional arrangements (long term contract). This level of analysis and the work of Williamson can certainly be very inspiring in an examination of the system of intellectual property. However, in this chapter, I would like to focus on a different level of analysis, somewhere between the institutional environment and Williamson's institutional arrangements. The question I am dealing with is whether technical communities in which numerous exchanges of knowledge and IPRs are able to set up coordination mechanisms that reduce transaction costs.

While the institutional environment and institutional arrangements such as those examined by Williamson have received the bulk of attention, other scholars have extended the analysis to other institutions, showing that communities throughout the world use many alternatives to market exchanges and hierarchical institutions.

For instance, Brousseau, Fares and Raynaud²⁴³ attempt to identify an intermediary mode of coordination between the institutional environment and the contractual institutional arrangements examined by Williamson that they designate "**private institutions.**" These private institutions have two characteristics. First, like the institutional environment but unlike contractual institutional arrangement, they are collective in the sense that the order they create is not entirely negotiated by each individual. Second, like contractual institutional arrangements and unlike the institutional environment, they are voluntary, in the sense that creating private institutions or joining them is voluntary.

In a book entitled *Governing the Commons*, Elinor Ostrom presents a wide array of field research on private institutions that administer common property resources. She focuses primarily on the observation of examples of common pool resources (CPR) governance²⁴⁴ as she believes

²⁴² Oliver Williamson (1985), *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, New York: The Free Press.

²⁴³ Eric Brousseau, M. Fares and E. Raynaud (2004) "The Economics of Private Institutions," - 8th ISNIE Conference-Tucson, USA.

²⁴⁴ Common pool resources (Cf. chapter 1) share two attributes of importance for economic activities. First, it is costly to exclude individuals from using the good either through physical barriers or legal instruments, therefore CPRs are subject to free riding. Second, the products of CPRs are rival; they are therefore subject to problems of congestion, overuse and potential destruction.

that the processes of self-regulation are easier to observe in this type of situation.²⁴⁵ The results of her work are not confined to the governance of CPRs, rather they are relevant for all situations where collective action and high transaction costs problems are present.²⁴⁶ In addition, she makes a link between forms of self-regulation and forms of common property regimes that can also be useful for this study.

Finally, as I already mentioned in Chapter Four, the work of law professor Robert Ellickson²⁴⁷ has focused on one specific category of coordination mechanisms, describing how social (non-legal) norms can emerge out of repeated interactions among members of close-knit communities and help to overcome collective action and transaction cost problems. My objective in this chapter is not so much to look at the process of spontaneous emergence of social norms. What I am interested in is rather their vulnerability in terms of enforcement as revealed in the example of the norms of science described in previous chapters. They cannot be enforced against third parties (external defection) and change in incentives can reduce members' compliance (internal defection). In an example described below, we will see that in order to improve their capacity of enforcement, members can either

245 Elinor Ostrom (1990), *Governing the Commons* (...), p. 26

²⁴⁶ One could say that there is a great similarity between the governance of CPR – often referred as the tragedy of the commons – and the anticommons tragedy. A tragedy of the commons is likely to surge when separate persons are assigned rights of use but no rights of exclusion. The classical example is a herder that may use the open commons as pasture but may not prevent others from doing the same. Thus, the exercise of the rights of use creates interdependencies that remain outside of the calculus of the choice makers (here the herders): there is a risk of overuse (overgrazing in the example). In the tragedy of the anticommons, the situation is basically symmetrical. The anticommons problem arises when there are multiple rights of exclusion. Individuals may reduce use of the commons by others who also can exercise their exclusion right. In the extreme situation, all members of a large group are assigned rights of exclusion, so that each potential user must secure the permission of all members; in that case, the resource may not be used at all despite its potential value. *The basic logic is equivalent in the two cases. The inefficiency arises because separate decision makers, each of whom acts in exercise of assigned right (either rights of use or rights of exclusion), impose external diseconomies on others who hold similar rights.* (James M. Buchanan and Yong J. Yoon (2000), “Symmetric Tragedies: Commons and Anticommons”, 43 JOURNAL OF LAW AND ECONOMICS 1). In other words, in both case, individuals acts independently in a situation of high interdependence and as long as they stay unorganized, they cannot achieved a joint return as high as they could obtain if they would organize to coordinate their action. Thus, in both situations, it is worth considering Ostrom's work on a theory of self-regulation and of common-property regimes.

²⁴⁷ See Robert C. Ellickson (1991), *Order without Law* (...)

create a private institution and/or “formalize” their social norms to rely on legal or external enforcement.²⁴⁸

In this chapter, I examine how different groups of knowledge holders²⁴⁹ modify their initial entitlements creating institutional arrangements to coordinate their exchanges of knowledge and IPRs. I use the expression “**collective rights organizations**” (“CRO”) to designate these institutional arrangements because they include a notion of common property or collective management of property rights.

6.2 The Notion of Collective Rights Organizations

The rationale for creating these collective rights organizations is **their ability to reduce of transaction costs**. First, they may reduce **search costs** with mechanisms that help to match providers and users. For instance, they may include a cadastre identifying precisely who holds what knowledge and what property rights. They may also work as a clearinghouse mechanism offering licenses to a large range of inventions or even package licenses. Second, collective rights organizations can also reduce **monitoring and enforcement costs** in several ways. Members can benefit from economies of scale if monitoring and enforcement involve fixed cost that can be shared.²⁵⁰ Specialization enables private enforcers to perform their task more efficiently. They can rely on alternative monitoring systems such as peer supervision. They can also include alternative dispute resolution mechanisms that are more responsive and specialized than courts. Also, they offer alternative (non legal) sanction mechanisms such as depriving those who do not fulfill their commitments from the benefits of the service provided by the CRO either through loss of reputation, ostracism or control of access. Last, adhesion to the rules should be higher as members take part in their drafting and voluntarily joined the CRO.²⁵¹

Third, collective rights organizations may reduce **bargaining costs** in several ways. They can notably offer economies of scale in the design of

²⁴⁸ In terms of enforcement, there are important differences between social norms and private institutions. Enforcement of social norms is decentralized; it is insured by peers without possibility to resort to state enforcement. By contrast, private institutions may include a centralized enforcement mechanism; it might be possible to resort to state enforcement if the construction of the private institutions leans on contracts and property rights.

²⁴⁹ Whether they have a formal IPR or not

²⁵⁰ Eric Brousseau, M. Fares and E. Raynaud (2004) "The Economics of Private Institutions," - 8th ISNIE Conference–Tucson, USA

²⁵¹ *Ibidem*

rules, as there are many redundancies in contracts ruling exchanges of property rights (licenses), and mandatory or optional standard contractual provisions allow parties to negotiate only a limited number of issues.²⁵² Collective rights organizations can also include collective valuation mechanisms. As I mentioned earlier, collective valuation can be more efficient than bilateral (market) valuation when there are important information asymmetries (information about the threat values and the bargaining surplus is private). Collective valuation by CROs can be more efficient than legislative or judicial liability rules: valuation is more customized because members have more expertise than legislators and judges; valuation is more responsive because valuation rules can be modified much more quickly than legislation.

It is worth observing that CROs often create some forms of **liability rules** to rule relations among their members and between their members and third parties; i.e. (1) the suppression of the need to obtain the consent of the right holder to have access to the protected knowledge, 2) a principle of *ex post* compensation and (3) a collective valuation mechanism that replaces bilateral negotiations. Therefore, in the analysis of collective rights organization we can combine the theoretical insights from entitlement literature and new institutional economics literature.

After observing that private institutions or collective rights organizations can be useful to reduce transaction costs, it is worth examining their **institutional design**. For this purpose, I follow the suggestion of Robert Merges and Michael Heller to look at the work of Elinor Ostrom. From observing a large number of successful and enduring private institutions, she identifies a series of design principles or elements that help to account for the success of these institutions²⁵³:

²⁵² *Ibidem*, p. 25

²⁵³ Elinor Ostrom (1990), *Governing the Commons...*, p. 90

a) Clearly defined boundaries

The boundaries of the resources collectively managed must be clearly defined, as must individuals who have rights to benefit these resources.

b) Congruence between appropriation and provision rules and local conditions

Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to provision rules requiring labor, material and/or money.

c) Collective choice arrangements

Most individuals affected by the operational rules can participate in modifying the operational rules

d) Monitoring

Monitors, who actively audit conditions of resources collectively managed and appropriators behavior, are accountable to the appropriators or are the appropriators

e) Graduated sanctions

Appropriators who violate operational rules are likely to be assessed graduated sanctions by other appropriators, by officials accountable to these appropriators, or by both.

f) Conflict-resolution mechanisms

Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials.

g) Minimal recognition of right to organize

The rights of appropriators to devise their own institutions are not challenged by external governmental authorities.

For resources collectively managed that are parts of larger systems

h) Nested enterprises

Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Last, one must observe that these collective rights organizations may modify the **property regime** for knowledge, creating intermediary situations between the two extremes of exclusive individual rights and the public domain.

6.3 Three Case Studies

The next paragraphs are devoted to the study of a few cases of collective rights organizations in IPRs where IPRs holders have succeeded in creating CROs that rely on liability rules to regulate relations among their members and between their members and third parties. For each example, I examine how collective rights organizations reduce transaction costs and possibly modify the initial property regime, and whether they follow the institutional design principles identified by Ostrom.

6.3.1 Inside Proprietary Technology: Patents Pools²⁵⁴

Attempting to overcome a possible tragedy of the anti-commons, or at least to find their way through patents thickets, firms resort to cross licensing or patents pools. A cross-license is an agreement between two companies that grants each other the right to practice the other's patents.²⁵⁵ Cross-licensing is a necessary and widespread phenomenon. When two companies each have a patent that overlaps with the other, cross-licenses are commonly negotiated where the use of each other's patents is essential for the development of products or processes. Rather than blocking each other and going to court or ceasing production, the two firms enter into a cross-license. Especially with a royalty-free cross-license, each firm is then free to compete, both in designing its products without fear of infringement and in pricing its products without the burden of a per-unit royalty due to the other. However, if the number of interdependent patents and the number of holders increase, if the valuation of the different patents is complicated, or if there is enduring interdependence between the patent holders, then a step further towards the creation of patent pools is likely to be considered.

²⁵⁴ This brief presentation is largely taken from the work of Robert P. Merges. For a detailed analysis of patent pools in a new institutional economics perspective see Robert P. Merges (1996), "Contracting into Liability Rules...", pp. 1337-1354 or Robert P. Merges (2001), "Institutions for Intellectual Property Transactions : The Case of Patent Pools" in Rochelle Dreyfus et al (eds.), *Expanding the Boundaries of Intellectual Property : Innovation Policy for the Knowledge Society*, Oxford University Press, New York , hereafter Robert P. Merges (2001), "Institutions for IP Transactions...". See also Robert P. Merges & Richard R. Nelson (1990), "On the Complex Economics of Patent Scope ", 90 COLUMBIA LAW REVIEW 83.

²⁵⁵ Carl Shapiro (2001), "Navigating the Patent Thicket: Cross-Licenses, Patents Pools and Standards Setting" in Adam Jaffe, Joshua Lerner, and Scott Stern (eds.) *Innovation Policy and the Economy, Volume I*, MIT Press

A patent pool is an arrangement among multiple patent holders to aggregate their patents. Among members of the pool, a large apparatus for cross-licensing is set up; members grant each other access to their patents (as well as their unpatented technical information) on standard terms, either for free or for a set price. Vis-à-vis third parties, patents pools constitute a single ticket office offering a package license. Typical patent pools allocate a portion of the licensing fees to each member according to a preset formula or procedure. Depending on the size and development of the pool, members of the pool can set up a central entity to which they assign or license their individual rights. In turn, this central entity exploits the collective rights by licensing, manufacturing, or both.

Thus, patent pools are collective rights organizations whose economic function is to facilitate licensing or exchanges of property rights by reducing **transaction costs**. To reduce bargaining costs, patent pools function according to liability rules. Under the rule of a patent pool, members are allowed to use any other member's technology for a set fee. Thus, once the pool is created, the three ingredients of liability rules are present: (1) the absence of necessary permission from the holder, (2) a principle of *ex post* compensation and (3) a mechanism of collective valuation. In some sense, patents pools may look like compulsory licenses but there is one major difference: in these organizations, the members, and not the legislator or a court, set the price. This involves extensive negotiations and sometimes, ongoing adjustments often carried out via a permanent administrative structure.²⁵⁶ Patent pools can also reduce other categories of transaction costs. They may reduce search costs for members by identifying precisely who owns what patents and associated know-how. They may also reduce search costs for third parties in constituting a single ticket office offering a package license. Finally, patent pools may reduce monitoring and enforcement costs either by limiting the need to monitor actions of members or by offering economies of scale in monitoring and sanctioning possible infringement by third parties.

Patent pools are not totally new. In the middle nineteenth century, there was a famous case in the United States involving the sewing machine industry. Early twentieth American jurisprudence also contains two notable pools in the context of the aircraft and automobile industries. After World War II, the number of pools has considerably subsided because antitrust authorities have been rather skeptical about this type of horizontal agreement. However, patent pools have been recurring in the

²⁵⁶ Robert P. Merges (1996), "Contracting into Liability Rules..."; pp. 1337-1354

last few years with the growing importance of collective innovation and the possible problems of patents thickets or anti-commons.²⁵⁷

It is also worth observing patent pools in terms of **property regimes**. They create a sort of two-tiered regime: conditions of access to a patented technology are not the same for non-members as they are for members. This difference can justify their close examination by antitrust authorities. What is interesting for this dissertation is that patent pools replace a system of private property rights with something like a common property regime or a “limited commons,” i.e. a scenario where property is held in common among the members of a group, but exclusively vis-à-vis the outside world.²⁵⁸ I will return to this later.

Regarding **institutional design**, to what extent can we say that Ostrom’s design principles are applicable in the intellectual property field? Principle (a) requires that the identity of the rights holders, and the specific patents pooled, must be clearly defined. This principle is quite obvious and it is likely to be the first step firms will take in considering setting up a patent pool. However, identifying actors in the long term in an evolving economic and technological context where new firms emerges and other disappear, (notably through vertical integration) might not be an easy task. Similarly, pool negotiators must be careful in stipulating whether or not the pool is confined to patents issued (or pending) as of the date of the creation, or to what extent it may include patents to be granted by a certain time in the future.

Principle (b) could be reformulated as a proportionality principle. At the heart of pools is the proportionality between each member’s contribution to the institution and his claim to common resources. One central element of patent pools is the provision of a system of collective valuation for each patent through contractual provisions and sometimes arbitration procedures so as to split royalties among members according to their proportional contribution.

Principle (c) concerns voting rules. Ostrom observes that institutions where most members affected by the rules can participate in modifying the rules are better able to tailor their rules and to modify them over time so as to better fit them to the specific characteristics of their setting. It is

²⁵⁷ Another important reason for considering the creation of patents pool is the issue of setting technical standards

²⁵⁸ This notion is developed by Carol Rose (1998) “Eldred v. Reno, The Several Futures of Property, of Cyberspace and Folk Tales, Emission Trades and Ecosystems”, 83 MINNESOTA LAW REVIEW 129

difficult to assess whether every patent pool respects this principle. At least, the two most analyzed patent pools in the aircraft and automobile industries had such governance structure, votes were given to all members but weighted to reflect their respective contributions.

Principles (d) and (e) require systems of monitoring and graduated sanctions. On this issue, the creation of a patent pool can only improve the situation of patent holders. Indeed, one characteristic of the IPRs system is that for the most part, enforcement of rights is left to rights holders. There are no “police” to detect patents infringement. Courts only become involved when a possible infringement is detected and a complaint is made by the patent holder. As in many long-enduring organizations observed by Ostrom, the costs of monitoring are lower in these organizations as a result of the rule in use. Similarly, patent pools both reduce the problem of infringement and reduce the costs of monitoring. As patent pools consist of sharing patented technology, their creation suppresses, for the most part, the issue of infringement among members. A residual problem might lie in the obligations to communicate the use made of other member’s technology and/or to pour new improvements into the pools. As patent pools create close-knit technical communities where potential free riders or shirkers are well identified, they effectively reduce monitoring costs.

According to principle (f), members should have rapid access to low-cost specialized arenas to resolve conflicts. Here again, it can vary according to the size and development of patent pools. Small contract-based pools might only have a valuation mechanism but larger institutionalized patent pools are likely to provide an arbitration mechanism or some other device to put an end to litigation.

Principle (g) provides that the rights of members to devise their own institutions are not challenged by external governmental authorities. Patent pools are relatively rare, at least formal ones. One possible explanation might lie in the governmental attitude which has varied from quasi-coercion to quasi-prohibition. Some pools have been created only when government helps to overcome the collective action problem. So, in several cases where a militarily useful technology was not being developed because of blocking patents, the United States government threatened to resort to eminent domain or compulsory licensing and this effectively contributed to the creation of patent pools. On the opposite side, formation of patents pools has long been restrained by the skeptical attitude of the antitrust authorities. Today, with the growing importance of collective innovation and the possible problem of patent thicket or

anti-commons, there seems to be increasing agreement among policymakers and economists that patent pools may benefit both intellectual property owners and consumers, provided that the pools include patents that are complementary or blocking.²⁵⁹

In conclusion, as observed by Professor Robert Merges, it seems that the validity of the design principles identified by Professor Elinor Ostrom goes much beyond natural resources management. Indeed, it appears that most of these principles are present in patent pools, which are an example of collective organizations in the field of IPRs.

I now turn to another case of collective rights organizations whose goal is not only the reduction of transaction costs but also the preservation of the social norms of Science.

6.3.2 Open Science: Formalizing the Norms of Science

As mentioned above, despite the fact that the two worlds of Science and Technology are increasingly intermingled and that patents are now available for an growing part of basic research, the norms of science, and particularly open access – or “communism” in Merton’s terminology – remain strong. However, despite this intellectual adhesion to the norms of science, one can observe a sizeable increase in patenting within universities and even more important a decrease in the sharing of research tools.²⁶⁰ In other words, the legitimacy of the norms remains strong while compliance is decreasing. This gap between intellectual adhesion to an open access norm and divergent practical behavior can be explained by a change in incentives. The increasing value of potential patents makes it more costly to comply with the norm of open access. Moreover, decentralized enforcement through non-legal sanctions, such as informal gossip or a highly unlikely exclusion of the academic community, is no longer sufficient, especially if the frequency of norm violations increases. Therefore, scientists are likely to seek patents and to

²⁵⁹ Josh Lerner & Jean Tirole (2002) “Efficient Patent Pools”, WP 9175, NBER

²⁶⁰ In the case of many research projects, scientists need not only access to information provided through publication or access to patented inventions, they need also access to biological material necessary to replicate or build on the initial results. The problem is that negotiating access through case by case material transfer agreement is very costly; and if transaction costs are too high, scientists will think that is not worth and the research material will not be shared. The situation might be more problematic in the US than in Europe because there is no clear research exception in US patent law as there exists in most EU countries.

be reluctant to share research tools, even if they believe that the scientific community would be better off given a widely respected open access norm.

There is, however, no fatality in this situation. Obviously, the law could be changed to modify the incentive for scientists or even better, scientists themselves may be able to self-regulate in response to this situation.

One can observe the behavior of some individual actors who attempt to define or shift downstream the boundary between open access and intellectual property, and in so doing overcome the risks of deadlock in the exchange of research tools. In numerous cases, scientists holding patents assert against the community only a limited set of rights and not the full exclusionary force bestowed by their patents. In a similar spirit, academic scientists and occasionally private scientists bypass the business and legal agents of their university or company, and freely exchange research tools.²⁶¹

Beyond these *ad hoc* measures, universities can also take more general and enduring initiatives to meet the challenges. The challenges concern both the content of the norms that must be adapted to new innovation and the enforcement of the norms. As to the content of the norms, scientists must identify criteria to distinguish discoveries that are better developed and disseminated through open access from discoveries that are better developed and disseminated with intellectual property rights; they must also identify which actor is best situated to make that decision. Regarding enforcement, they need to design devices to enforce the norm of open access when it best suits. Hereafter are some examples of such initiatives.

In 1995, the American Association of University Technology Managers (AUTM) proposed a new standard contract for the transfer of biological research tools called the **Uniform Biotechnological Material Transfer Agreement (UBMTA)**.²⁶² This initiative is worth examining for a series of reasons.

Concerning the content of the norms, this standard material transfer agreement (MTA) codifies into contract what scientists think are the best

²⁶¹ Rebecca S. Eisenberg (2001), "Bargaining over Proprietary Research Tools..."

²⁶² 60 Fed. Reg. 12771 (March 8, 1995). The text is also available at <http://www.autm.net/UBMTA/intro.html>

practices in terms of knowledge and IPRs exchange. In so doing, **the content of the norm of open access is written down and updated.** The uniform MTA actually leans upon four distinctions; the two first are old distinctions while the last two are new and directly related to the Bayh Dole Act. A first distinction is between two types of uses: non-commercial purposes (research and teaching) on the one hand and commercial purpose on the other. A second distinction is between research material users: profit organizations and non-for-profit organizations. A third distinction is between two types of rights: access rights and use rights. And in a later stage, a fourth distinction has been added concerning the objects of the MTA that are either better used through shared access or resources that can be used with some form of proprietary control.

The UBMTA provides that non -profit organizations may agree to give themselves mutual access to their biological research material. The material is provided at no cost or with an optional transmittal fee solely to reimburse preparation and distribution costs. However, this mutual access is limited to teaching and research purposes, any commercial use requires the negotiation of a classical license and the provider is under no obligation to grant such a license. Any transfer of material to a for-profit organization is deemed to be a commercial purpose. Provision of material from non-profit organizations to for-profit organizations is not covered by the UBMTA, each organization can negotiate these scenarios on a case-by-case basis, or according to their own standard contracts. Provision of material from industry to non-profit is the object of another text, whose content is similar to the UBMTA, but which has remained in a draft form.²⁶³ What is new is an implicit distinction between access rights and use rights. The UBMTA is actually an incomplete contract. The provider gives free access to its research material, i.e. the right to work on it for research (and teaching) purposes and the material remains the property of the provider. Consequently, as mentioned before, any commercial use of the material requires the prior consent of the provider. In the event of success, i.e. the realization of an innovation containing this material, the recipient must negotiate the use rights of the material.²⁶⁴ The fourth distinction will be described further in this

²⁶³ The text is also available at <http://www.autm.net/UBMTA/intro.html>

²⁶⁴ It is worth keeping in mind the main characteristics of this model contract for the second and third part of this dissertation, as this template contains many ingredients very similar to the claims of biodiversity rich countries and communities about their

Chapter. **Regarding transaction costs**, the UBMTA has a similar effect as it codifies and updates the norm of open access. The UBMTA offers a set of standard contractual terms that can significantly reduce bargaining costs. In regards to other categories of transaction costs, its effect is more limited. There is no obvious effect on search costs; it partly reduces monitoring²⁶⁵ and enforcement costs by providing mutual access to biological material for teaching and research purposes, i.e. those uses where transaction costs might be higher than the cooperative surplus and therefore prevent exchanges of biological material (*Cf. chapter 4*). Commercial uses, however, must still be monitored.

In terms of property regimes, the drafting of the UBMTA creates or rather codifies the creation of a two-tier property right regime: it distinguishes exchanges between non-profit organizations themselves, and exchanges between non-profit organizations and for-profit organizations. Nevertheless, the situation is substantially distinct from the original one or at least from the idealistic Mertonian description of Science. This regime of shared-access within Science is very different from an open-access and free use regime. Scientists are induced to pour their research materials into a “limited commons” rather than into the public domain (open access).²⁶⁶

What can be said about UBMTA in terms of institutional design? The UBMTA has had limited success, at least in its first stage. Many of the signatory universities substitute their own agreements for the UBMTA when they send their materials out to other universities. These agreements are often more restrictive and need to be reviewed by institutional representatives before being accepted. One possible explanation for this limited success may be that the agreement does not fulfill all of the **design principles** identified by Ostrom. The distinctions made between different categories of users (non-profit/ for-profit organizations) and different uses (research and teaching/commercial uses) are applications of design principles (a) and (b). The negotiation of

genetic resources and traditional knowledge. I refer above all to two issues: prior informed consent and indication of the material origin.

²⁶⁵ The UBMTA could also reduce the costs of monitoring the departure from the norm of open-access; substituting the UBMTA by a material transfer agreement with more restrictive terms is tantamount to signaling a departure from the norm.

²⁶⁶ Robert P. Merges (1996), “Property Rights Theory and the Commons...” p. 160. Arti Rai and Rebecca Eiseberg call it a “limited public domain among universities” see Arti Rai and Rebecca Eiseberg (2003), “Bayh-Dole Reform and the Progress of Biomedicine” 66 LAW AND CONTEMPORARY PROBLEMS 289, p. 306 hereafter Arti Rai and Rebecca Eiseberg (2003), “Bayh-Dole Reform and...”

the UBMTA within the Association of University Transfer Managers is (partly) an application of design principles (c). However, the weakness of the UBMTA is in its **enforcement**: it does not include a mechanism for monitoring and sanctioning (design principles d and e); actually, it is not even mandatory among signatories. As explained above, without monitoring, commitment will be weak. In addition, there is no conflict-resolution mechanism when a university refuses to resort to the UBMTA and rather imposes more restrictive conditions. When the enforcement of norms is weak, one possible solution is to look for external coercion.

Interestingly, a solution came from the National Institute of Health (NIH), the principal source of public funds in American Bio-medical research. Except in very limited circumstances, and after long procedures, the NIH has no legal power to constrain its grantees to make their inventions more available.²⁶⁷ However in several circumstances, the NIH has successfully exhorted its grantees to act collectively to keep basic research results in the public domain. After some *ad hoc* interventions,²⁶⁸ in 1999 the NIH adopted a more general statement of “*Principles and Guidelines for Sharing Biomedical Research Resources*”²⁶⁹ to guide its grantees in their claim and exercise of property rights. Basically, the content of these principles and guidelines is similar to the UBMTA and they explicitly recommend its use. The *Principles and Guidelines* only add useful criteria to distinguish between different types of research resources to help research institutions determine the best strategy (patent, shared access or public domain) in order to enhance the

²⁶⁷ 5 U.S.C. §.202 (b) 1

²⁶⁸ Concerning human genome mapping see NHGRI Policy Regarding Intellectual Property of Human Genomic Sequence (April 9, 1996) *available at* <http://www.nhgri.nih.gov>. See also the “the Bermuda rules”, which require publicly-funded investigators to deposit all newly identified DNA sequences and mutations in the publicly-accessible GenBank database within 24 hours, (they derive their name from an agreement entered into at the International Strategy Meeting on Human Genome Sequencing held in Bermuda in 1996). For SNPs, the NIH undertook a similar strategy before the SNP Consortium stepped forward to put SNPs in the public domain, see National Institutes of Health RFA HG-98-001, Methods for Discovering and Scoring Single Nucleotide Polymorphisms (January 9, 1998), *available at* <http://www.nih.gov>

²⁶⁸ Department of Health and Human Services, National Institutes of Health, Principles and Guidelines for Recipients of NIH Research Grants and Contracts on Obtaining and Disseminating Biomedical Research Resources: Final Notice, 64 Fed. Reg. 72,000, 72,093 (December, 23, 1999)

²⁶⁹ Department of Health and Human Services, National Institutes of Health, *Principles and Guidelines for Recipients of NIH Research Grants and Contracts on Obtaining and Disseminating Biomedical Research Resources: Final Notice*, 64 Fed. Reg. 72,000, 72,093 (December, 23, 1999)

ultimate availability of the resource (*cf.* Ostrom design principles (a) and (b)):

"Recipients should determine whether: 1) the primary usefulness of the resource is as a tool for discovery rather than an FDA-approved product or integral component of such a product; 2) the resource is a broad, enabling invention that will be useful to many scientists (or multiple companies in developing multiple products), rather than a project or product-specific resource; and 3) the resource is already useable or distributable as a tool rather than the situation where private sector involvement necessary or the most expedient means for developing or distributing the resource. Recipients should ensure that their intellectual property strategy for resources fitting one or more of the above criteria enhances rather than restricts the ultimate availability of the resource."

But, probably the most important point of the NIH intervention is that it has given the small dose of monitoring and sanctioning necessary to enforce the norms of free access (design principles (d) and (e)). The dose is very small indeed as the NIH's constraint on the discretion of research institutions has little legal weight. It is no more than a grant policy though it has enjoyed some success.²⁷⁰

Thus, it appears that left to their own devices, American universities may not be able to take sustained collective action in favor of the public domain. However, the NIH intervention has shown that with a little help from outside, the situation may look different. Ostrom highlights the importance of external factors, notably the political regime. Here, support in terms of monitoring and sanctioning in the form of the NIH grant policy seems preponderant (design principles (g) and (h)). Nevertheless, it may not be totally sufficient which is why some American scholars call for modifications to patent law.

Law can facilitate enforcement of social norms in several ways. The provisions for norms can be written down in a contract that can be enforced by court²⁷¹. The provisions of the norms can also be turned into law by law-makers or courts that give legal force to social norms.²⁷² Also, the law can be changed to modify incentives that act on scientists.

Several scholars have called for a revaluation of patent's utility doctrine.²⁷³ Some steps in the direction of legal change can already be

²⁷⁰ Arti Rai and Rebecca S. Eisenberg (2003), "Bayh-Dole Reform and..."

²⁷¹ I explore this possibility in part two and above all in part three.

²⁷² On this issue see notably Robert D. Cooter (1996), "Decentralized Law for a Complex Economy: The Structural Approach to Adjudicating the New Law Merchant", UNIVERSITY OF PENNSYLVANIA LAW REVIEW

²⁷³ See Rebecca S. Eisenberg (2000), "Analyze this ..." at 85-88 ; Arti K. Rai and Rebecca S. Eisenberg (2003), "Bayh-Dole Reform and ...", p. 299; Michael A Heller (1999), "The Boundaries of Private property", 108 THE YALE LAW JOURNAL 1163, at

observed. The guidelines on utility issued by the U.S. Patent and Trademark Office in 2001 exclude upstream research results from patent protection unless research has a “specific, substantial, and credible” utility (see Chapter Three).²⁷⁴

Another much-discussed proposal²⁷⁵ is the “experimental-use doctrine” which would exempt non-commercial research from infringement liability. One possible effect of this doctrine would be to codify and reinvigorate the eroding practices within the scientific communities. Indeed, if the availability of upstream patents has modified the incentives of scientists leading to departures from the (non-legal) norm of open access and if there have been attempts to formalize the norm in a voluntary standard contract (the UBMTA) and in the NIH guidelines, then it might be worth codifying this norm in the law. However, this is not the solution followed by the Federal Circuit.²⁷⁶

Before drawing some conclusions on actors’ capacity to coordinate and modify their initial entitlements, I would like to turn to another type or collective organization: research consortiums. They have different features than patent pools. First, they organize cooperation among academic research centers or among academic researchers and private firms; consequently they are confronted with the combination of both cultures and their respective requirements. Second, for the most, they are *ex ante* agreements, they arise from a common will of future cooperation

1174; Robert P. Merges (1996), “Property Rights Theory and The Commons...” p. 165; Arti K. Rai (2001), “Fostering Cumulative Innovation in the Biopharmaceutical Industry: The Role of Patent and Antitrust”, 16 BERKELEY TECH. L. J 813, at 840-41.

²⁷⁴ *Utility Examination Guidelines* (2001), 66 Fed. Reg. 1092, 1098 (January 5)

²⁷⁵ See Janice M. Mueller (2001), “No Dilettante Affair: Rethinking the Experimental Use Exemption to patent Infringement for Biomedical Research Tools”, 76 WASH. L. REV. 1; Maureen O’Rourke (2000), “Towards a Doctrine of *Fair Use* in Patent Law”, 100 COLUMBIA LAW REVIEW 1177 or Rebecca S. Eiseberg (1987), “Proprietary Rights and the Norms of Science in Biotechnology Research”, 97 THE YALE LAW JOURNAL 177 at 220-231

²⁷⁶ See *John M.J. Madey v Duke University*, 307 F.3d 1351, (Fed. Circ. 2002) 64 USPQ 2d. The basic rule established by the Court is that: “[R]egardless of whether a particular institution or entity is engaged in an endeavor for commercial gain, so long as the act is in furtherance of the alleged infringer’s legitimate business and is not solely for amusement, to satisfy idle curiosity, or for strictly philosophical inquiry, the act does not qualify for the very narrow and strictly limited experimental use defense. Moreover, the profit or non-profit status of the user is not determinative.” The Supreme Court refused to grant review in *Duke University v. Madey*, No. 02-1007, cert. denied 539 U.S. 958, (June 27, 2003).

rather than from an existing blocked situation. Finally, the research consortiums I briefly examine here are based in Europe.

6.3.3 Research Consortiums: Multilevel Agreement and Open, Semi-Open and Closed Spaces

In the context of collective innovation where IPRs are granted on small pieces of innovation, the collecting of all rights to assemble a final product might be very costly. Cross-licensing or patent pools are more or less institutionalized forms of IPRs and knowledge exchanges. Creation of research consortiums is another possibility; it allows associating public research centers, firms, or both to coordinate their future research efforts. Since, the number of these consortiums is increasing, as collective innovation becomes the norm, it is interesting to observe how scientists create these new institutional forms of coordination. The following analysis leans upon the work of Dominique Foray and Maurice Cassier²⁷⁷ who carried out several detailed studies of research consortiums funded by the European Union.

Cassier and Foray identify four sources of tension for which consortium members must find the right balance. First, they have to balance a certain degree of knowledge sharing to stimulate collective innovation with a degree of individual protection to incite partners to participate and engage existing confidential resources. Second, they have to draw allocation rules for research results according to the nature of the results, their mutual contribution, and their cooperation/competition relation. Third, they have to find a compromise on the difference of access between members and non-members. Finally, when the consortium gathers academic research centers and private firms, they have to conciliate the requirement of rapid publication of the former with the latter's needs of withholding and appropriation.

To this end, research consortiums set rules on the timing and the levels of diffusion of knowledge and data. Depending on the type of consortium, Cassier identifies up to four levels of access. The first circle consists of the "team data" that are accessible only to the members of one research center – or a subpart of the consortium – After a short period, they must be transferred to all the consortium participants. The

²⁷⁷ Maurice Cassier & Dominique Foray (1999), « La régulation de la propriété intellectuelle dans les consortiums de recherche : les types de solutions élaborées par les chercheurs », *ECONOMIE APPLIQUEE*, Tome LII, n°2, pp.155-182 and Maurice Cassier (2002) « L'appropriation des connaissances dans les partenariats de recherche entre laboratoires publics et entreprises: quelques tendances récentes », Working Paper IMRI

second circle is made up of the “pooled data” accessible to all participants and may not be communicated to third parties without the authorization of the author of these data. The third circle lies in the data communicated to a circle of firms that are not members of the consortium but pay a right to access data before publication. The fourth circle consists of the “public data” that are made available to any potential user by publication or deposit in a public database. This concentric diffusion process allows participants to conciliate the advantage of both reward systems (patent and priority in publication). Consortia tend to organize a regime of slightly postponed diffusion; in so doing, they enable members to sell access to confidential knowledge or to apply for a patent.²⁷⁸ This period is relatively short (a few months) because it slows down the researchers in their course to priority publication. But, most of all, the second circle of “pooled data” creates an area of collective invention among all the participants. These “pooled data” have a hybrid nature mixing characteristics of public goods and private goods; some economists could call them “club goods.”²⁷⁹ They are placed in a temporary legal regime of common property or limited commons before becoming public data (*cf. infra*).

These rules of diffusion are completed by **a set of rules on the allocation of property to the results**. According to the general principle set in the European standard contract, property is given to the author of the results. However, situations of collective inventions require more tailored attribution rules. Cassier and Foray observe that scientists manage to design custom-made attribution rules in function of several factors such as the characteristics of the research object (whether it is divisible or not), the property of the pre-existing resources invested in the collective research, or the nature of the collective innovation process (the level of cooperation/competition). Participants can set a mechanism of *separate property* when the consortium is based on the gathering of research material belonging to different and rival authors. In that case, the collective innovation process is limited to the sharing of research data; material and technological developments remain exclusive. They can also resort to a mechanism of *divided property*. This system is likely to be used when participants work on a divisible object (e.g. the genome) and have at their disposal a precise sharing tool (e.g. a cadastre). In this case, the collective innovation process consists of a work division, and

²⁷⁸ Indeed, in European patent law by contrast to U.S law, there is no grace period and the patent is granted to the first to file rather than the first to invent. Thus, immediate diffusion of the results would destroy the possibility to obtain a patent.

²⁷⁹ Club good is the denomination given to goods that are excludable like private goods and non-rival like public goods.

members work in parallel. Above all, scientists can also choose a system of *collective property*. They will resort to such a system especially when they do not have a sharing tool or when research results are by nature collective, i.e. the contribution of participants are highly complementary. Obviously, the management of collective property is a delicate issue that can require the creation of an additional institutional device. For instance, in the Eurofan consortium, they created a trust to manage this collective property and transactions with third parties.

As for institutional design, if we confront the organization of these consortiums, it appears that for the most part Ostrom's **design principles** are all present. These systems of concentric diffusion and property allocation are an application of principle (a) on clearly defined boundaries, as well as principle (b) on the congruence between appropriation and provision rules and local conditions. Cassier and Foray note that all the consortium agreements they have analyzed have been elaborated by scientists (c). They observe further that this elaboration by local actors facilitates their coordination and the application of the rules. Consortiums analyzed have some mechanisms of monitoring and arbitration in case of conflict ((d) and (f)). Then, participants in a consortium enjoy recognized freedom to organize (g). Indeed, the European Union, which is the principal source of funding for these consortiums, provides them with legal resources such as a standard consortium agreements while giving them large autonomy to adapt their own rules to the special features of their organization. The degree of formalization and the legal status of these rules can vary: some rules are unwritten and can be only the object of oral discussions, some are written as guidelines, others lie in formal contracts that could be invoked in courts. Often, these contracts or guidelines are given legal recognition through their inclusion in the contract negotiated between the European Union and the consortium. Finally, the last principle (h) on nested organizations is also present. Out of Cassier and Foray's description, it appears that consortiums are often included in larger systems, either larger consortiums or in a network of privileged users. In a separate study,²⁸⁰ Cassier identifies an interesting case created by the French National Institute for Agricultural Research (INRA). A consortium of seven European academic research centers collectively produced a large collection of gene sequences. It was decided that after a short period of time the collection would be placed in the public domain

²⁸⁰ Maurice Cassier (2002) « L'appropriation des connaissances dans les partenariats de recherche entre laboratoires publics et entreprises: quelques tendances récentes », Working Paper IMRI pp. 107-110

and consortium members or their industrial partners could not be prevented from using the patents on modified genes derived from the collection. According to the rules of the consortium, all members are free to apply for a patent but they must grant licenses to the consortium members as well as the industrial partners of each of the consortium members. This process thus creates a two levels network and a community of licensees. The coordination organized among academic research centers for the upstream stages of research is thus extended to the industrial partners and to the downstream stages of the research.

In brief, these consortiums constitute successful examples of self-regulation by actors involved in a process of collective innovation. As in the precedent example, we face a two-tiered (or multilevel) regime, one that rules exchanges among members, and another that rules exchanges with third parties. In so doing, they create a form of common property or limited access commons. Within this limited commons, relations are ruled by a principle of reciprocity (shared access), which is buttressed by a mechanism for compensation (liability rule) in situations where the contribution of members is not equal.

In the examination of each of the above collective rights organizations, I referred to the fact that these organizations create something like a new property regime for knowledge: a common property or a limited commons. It is now time to dwell on the possible evolution of the different property regimes for knowledge.

6.4 Intermediary Forms of Property Regimes

In the first chapter, I described how knowledge is a public good, i.e. a non-rival good and a non-excludable good. This implies that from the appropriation viewpoint, knowledge should be in open-access, i.e. in the public domain, as there is no risk of overuse. However, from the provision viewpoint there is an incentive problem. As the knowledge produced by an agent benefits third parties without compensating the agent, the agent will have no incentive to invest in the production of knowledge. Consequently, there are two imperfect solutions to this knowledge dilemma. First, the state can modify the incentives to produce knowledge, creating legal means that provide some temporary exclusivity in knowledge. Second, the state can provide the funds for the production of knowledge and the knowledge so produced will be in open-access, i.e. in the public domain.

It is observable from the previous section that the range of property status for knowledge might be larger than the classical categories: temporary private property rights and open access. To refine this observation, it might be interesting to follow the suggestion of Professor Carol Rose,²⁸¹ a property law specialist, who resorts to the Roman law developments and legal thought on non-exclusive forms of property. Very briefly, five categories of non-exclusive property existed in Roman law and were defined as follows:

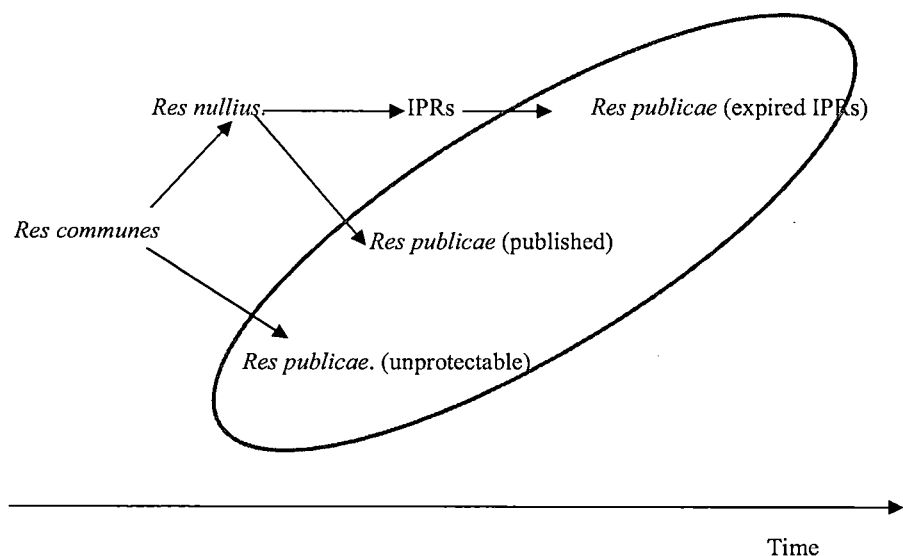
<i>Res nullius</i>	Things that are not by their nature nonexclusive; they have simply not yet been appropriated by anyone
<i>Res Communes</i>	Things incapable of "capture" or any other act of exclusive appropriation. They are open to all by their nature
<i>Res Publicae</i>	Things belonging to the public and open to the public by the operation of law
<i>Res universitatis</i>	Property belonging to a (public) group in its corporate capacity
<i>Res divini juris</i>	Things that are unowned by any human being because they are sacred, holy or religious

From these categories, it can first be argued that as knowledge is a non-excludable good (except through secrecy) it can be seen as *res communes*. Then, Professor Rose suggests that the function of intellectual property law is to turn some *res communes*, things by their nature incapable of ownership, into *res nullius*, things not yet owned but capable of appropriation. Under certain conditions, intellectual property law gives a temporary property right to some pieces of knowledge. When the patent or copyright expires, the encapsulated knowledge does not become *res nullius* again, open to new appropriation, but rather *res publicae*, wide open to the public through the operation of law.

Furthermore, it is argued that the public domain fits into the definition of *res publicae*: under intellectual property law, knowledge placed in the public domain belongs to the public. To refine the analysis, it can be said that knowledge turns into *res publicae*, or in other words, is placed in the public domain at three different stages. Under intellectual property law, some pieces of knowledge cannot be appropriated, e.g. general ideas, discoveries, etc.; these things are thus immediately turned into *res publicae*. Other pieces of knowledge are turned into *res nullius*. In that case, these

²⁸¹ Carol Rose (2003), "Romans, Roads, and Romantic Creators: Traditions of Public Property in the Information Age" 66 LAW AND CONTEMPORARY PROBLEMS (Winter/Spring) p. 89, hereafter Carol Rose (2003), "Romans, Roads, and Romantic Creators..."

pieces of knowledge can be either published (e.g. by an academic researcher) and turned into *res publicae* or protected by intellectual property rights. If they are protected by intellectual property rights (e.g. by a firm), when the duration of the rights runs out, the pieces of knowledge will end up as *res publicae* as well. Consequently, what is interesting with intellectual property law is that sooner or later, all knowledge is turned into *res publicae*.

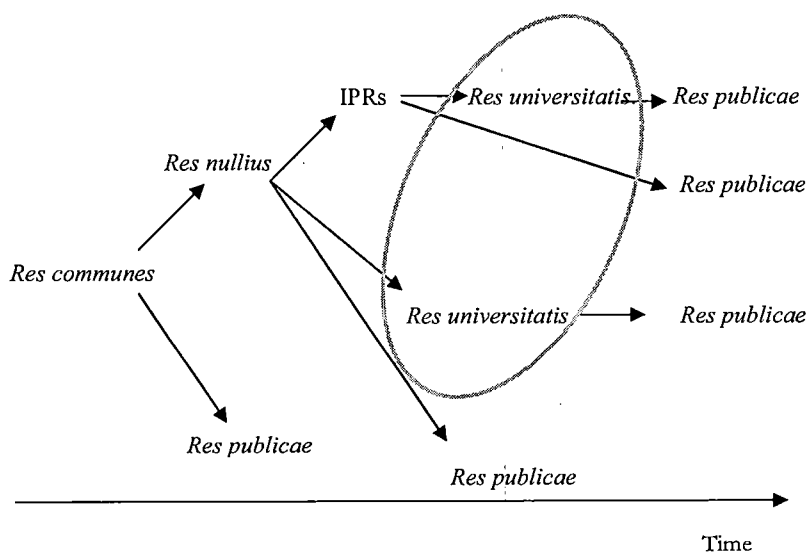


Source: author

Throughout the analysis of the evolution of intellectual property law, one can observe the development of some forms of common property regimes. Thus, it might be useful to turn to another Roman law category, *res universitatis*. *Res universitatis* refers to property belonging to a group in its corporate capacity. It can exist when a resource is too large for individual ownership, but still sufficiently bounded that it can be joint-managed by a limited group. In the intellectual field, this notion acknowledges the usefulness of property rights in creative accomplishments while encouraging interaction and cooperative joint management that foster inventiveness.

Going back to the schema of evolution through time of the property status of intellectual matters, *res universitatis* might well be an additional stage on the path from *res communes*, things that cannot be appropriated, to their final destination, *res publicae*, things open to all by operation of

law. On the basis of the different cases of collective rights organizations examined above, one can distinguish two different situations. First, in the UBMTA or in research consortiums, academic scientists agree to share information (*res nullius*) with others in the same intellectual pursuits and to enjoy creative synergies. These academic scientists, however, are unwilling to share the same information with commercial firms or third parties, notably for lack of reciprocity. Thus, through the drafting of UBMTA or the creation of a research consortium, they turn their information into temporary *res universitatis*. Second, there are situations where several firms hold IPRs on complementary pieces of knowledge. As these pieces of knowledge cannot be used independently, they may turn their IPRs in a *res universitatis*, and create a patent pool



Source : author

Here, Ostrom's work on common property and collective rights organizations concurs with the Roman law terminology. A *Res universitatis*, or limited commons being more limited in membership than the public at large, might generate a rather dense set of rules or social norms. In the intellectual field, these rules and norms in turn can help to limit both the risk of under-use for lack of knowledge sharing and the problem of under-provision for lack of incentive.

A small clarification of terminology must be made. Neither Roman law nor Professor Rose makes a clear distinction between the nature of the good and the form of the property regime. In this dissertation, I have distinguished four **categories of goods** (private goods, club goods, common pool resources and public goods) according to two distinctions: rival/non-rival, excludable/non-excludable). One can also distinguish different **property regimes** according to the identity of the owner: an individual, a group, the government or the public at large. In the light of the distinction between the nature of the good and the form of property regime, it appears that the expression *res communes* designates a type of good and not a property regime; *res communes* are things incapable of ownership (non exclusive-goods), either public goods or common pool resources. By contrast, the four other expressions designate different property regimes.

More broadly, the different authors I mention in my reconstruction of a history of intellectual property law do not use a unified terminology to designate different forms of property regimes. It might therefore be useful to classify these expressions used and to gather those with similar content.

It is also worth integrating in this classification the entitlement theory distinction between liability rules and property rules. In so doing, it is important to keep in mind that there is a continuum starting from property rules, passing by liability rules and ending with the public domain. Professor Reichman argues that property rules and the public domain are two extreme cases of liability rules. In the public domain there are minimal restrictions on how the property may be employed and the price users pay is zero or limited as to the cost of transferring the property from the innovator to the user. At the other extreme, property rules use restrictions so severe that the effective price users pay for the property without the consent of the innovators is infinite.²⁸²

²⁸² Jerome H. Reichman & Tracy Lewis (2005) "Using Liability Rules to Stimulate Local Innovation in Developing Countries: a Law and Economics Primer", in Keith E. Maskus and Jerome H. Reichman (eds.) *International public Goods and Transfer of Technology Under a Globalized Intellectual Property Regime*, Cambridge University Press

<i>Expressions</i>	<i>Type of access and valuation mechanism</i>
<i>Property rule</i>	-Access is submitted to the prior consent of the right holder -Bilateral Valuation (by the parties)
<i>Liability rule or Paying public domain</i>	-Access is not submitted to the prior consent of the right holder -But compensation is required -Collective valuation
<i>Limited commons or Shared access or Res universitatis Common property</i>	Within the group -Access is not submitted the prior consent of the right holder -Usually compensation is not required, however a compensation can be required especially if contribution of the members are not equal (liability rule) - Collective valuation when a compensation is due Vis-à-vis the outside world -Access is submitted to the prior consent of the right holders individually or as a group
<i>Public domain or Open-access or Res Publicae</i>	-Access is not submitted to prior consent -No compensation is due
<i>Open-content + copyleft or Inalienable public domain²⁸³ or Share alike</i>	-Access is not submitted to prior consent -No compensation is due -Derived product including the accessed knowledge must be accessible under the same conditions. -Obligation to include a similar condition in subsequent transfers

6.5 A New Issue: Favoring the Emergence of Collective Rights Organizations

Collective rights organizations can enhance the welfare of their members by reducing transaction costs. However, it does not mean that they will automatically emerge each time they could be useful. Indeed, problems of collective action may arise in the process of creating a collective rights organization, as a public good is provided. Because of free riding collective rights organizations could fail to emerge.

It is important to examine the literature on the emergence of such coordination mechanisms based either on empirical²⁸⁴ or historical

²⁸³ This expression is used by Anupan Chandler and Madhavi Sunder (2004), "The Romance of the Public Domain" 92 CALIFORNIA LAW REVIEW 1331

surveys,²⁸⁵ or on game theory analysis.²⁸⁶ From this literature, one can observe a large convergence but a lack of precision in the identification of the conditions in which individuals are likely to stop acting independently and start coordinating. All the literature observes congruence between private institutions and the existence of “communities”, but without much more precision. In an effort to elaborate on this notion of community, Elinor Ostrom lists a series of **internal characteristics** of a group facing a collective action problem positively related with the likelihood of starting to coordinate their action:

- 1) Most members share a common judgment that they will be harmed if they do not adopt an alternative rule
- 2) Most members will be affected in similar ways by the proposed rule change
- 3) Most members have a low discount rate. In other words, individuals are more likely to start coordinating their actions if they highly value the continuation of their common activity.
- 4) Members face relatively low information, transformation and enforcement costs. In other words, members of a group are more likely to coordinate if the costs for the group of considering a rule change, of effectively changing the rules and of monitoring and sanctioning the possible infringement of the rule are low.
- 5) Most members share generalized norms of reciprocity and trust that can be used as initial social capital.
- 6) The group is relatively small and stable.²⁸⁷ (repeated interaction)

²⁸⁴ See notably Elinor Ostrom (1990), *Governing the Commons (...)* or Robert C. Ellickson (1991), *Order without Law (...)*.

²⁸⁵ See notably Avner Greif (1989), “Reputation and Coalitions in Medieval Trade: Evidence on the Maghribi Traders”, 49 JOURNAL OF ECONOMIC HISTORY 857-882; Milgrom, Paul R., Douglass, C. North, and Barry R. Weingast, (1990), “The Role of Institutions in the Revival of Trade: the Law Merchant, Private Judges, and the Champagne Fairs”, 2 ECONOMICS AND POLITICS 1-23; Bruce L. Benson (1989), “The Spontaneous Evolution of Commercial Law”, 55 SOUTHERN ECONOMIC JOURNAL, 644-661.

²⁸⁶ See notably Robert D. Cooter (1996), “Decentralized Law for a Complex Economy: The Structural Approach to Adjudicating the New Law Merchant”, UNIVERSITY OF PENNSYLVANIA LAW REVIEW or Francesco Parisi (1999) “Spontaneous Emergence of Law: Customary Law” in Boudewijn Bouckaert and Gerrit De Geest (eds.) *Encyclopedia of Law & Economics*, <http://encyclo.findlaw.com/>

²⁸⁷ Elinor Ostrom (1990), *Governing the Commons, (...)* p. 211

What can be observed in the examples examined here above? Regarding the examination of successful patent pools, as is done by Robert Merges, it seems to confirm Ostrom's internal characteristics for the study of collective organizations created in the field of IPRs. Indeed, members of successful patent pools seem to share most internal characteristics of a group positively correlated with likelihood of stopping to act independently and starting to coordinate their action, setting up institutions and modifying their initial entitlements. One must keep in mind, however, that the mere existence of some successful patent pools does not imply that economic actors owning complementary pieces of knowledge will always succeed in integrating them. In addition, successful patents pools would not have emerged without some form of government intervention.²⁸⁸

For example, the American academic community working in biotech possesses, at least partly, the internal characteristics identified by Ostrom as positively related with the likelihood of overcoming the collective action problem and adopting new rules to improve their joint welfare. Moreover, more than 100 universities, including all the major research universities, have signed the UBMTA as the governing document for the materials that scientists receive from other institutions. The existence of the UBMTA thus seems to confirm the positive correlation identified by Ostrom. The fact that a similar agreement aimed at ruling material transfers from for-profit to non-profit organizations remained as a draft could be explained by the fact that in 1995 the biotech community at large (including both academic scientist and firms) did not possess all the characteristics identified by Ostrom. However, as described above, the presence of these characteristics does not imply the automatic formation of a successful collective rights organization. In this case some form of government intervention has also been useful, not so much for the emergence of a collective rights organization but rather for enforcement.

Concerning the third case study, research centers that set up a consortium constitute a group with all the internal characteristics identified by Ostrom which point to increasing the likelihood of coordination. The situation can be a little more complicated when the consortium includes both academic centers and private firms. In this situation, members of the consortium often resort to two-tiered regimes to preserve different social norms. In this example, once again some

²⁸⁸ Arti K. Rai (1999) "Regulating Scientific Research...", p. 132 and Robert P. Merges (1996) "Contracting into Liability Rules...", p. 1352

form of governments support has facilitated the creation of these research consortiums. Indeed, The European Union, one of the main funders of these consortiums, provides them with template contracts that can be seen as default rules, permits researchers to adapt their own rules, and endorses the rules on which they have settled.

In sum, if Ostrom's theoretical insights appear applicable in the intellectual property field and if in some circumstances actors seem able to coordinate their actions, to modify their initial entitlements and to set up collective rights organizations, it is far from clear that it will always be the case and that no bargaining failure is to be feared. The economic theory of intellectual property has made much progress by placing the coordination of knowledge and IPRs exchanges at the center of its research agenda and by integrating the lessons of the entitlement literature and new institutional economics. However, intellectual property theory still needs to suggest solutions for situations where collective rights organizations would be efficient but do not emerge. In other words, we must still strive to understand when and how government (law) can facilitate the emergence of these collective rights organizations.²⁸⁹ On this issue, competition law has long been a hindrance to the creation of CROs because of the fear of cartelization.²⁹⁰ Recently, antitrust authorities have been more receptive to inter-firm collaborations aimed at coordinating knowledge and IPRs exchanges (or setting technical standards).²⁹¹ It might not be enough to remove obstacle to the creation of CROs, their creation might require positive encouragement. Professor Reichman has suggested a possible solution..²⁹² He explores whether the propensity to stop acting independently and to coordinate in order to create a collective rights

²⁸⁹ In this sense see notably Arti K. Rai (1999) "Regulating Scientific Research...", Jerome H. Reichman & Tracy Lewis (2005) "Using Liability Rules..." and Jerome H. Reichman (2000), "Of Green Tulips..."

²⁹⁰ A limit of self-regulation consists in negative externalities: it is not because a self-regulation is efficient for the members of particular social groups that they are efficient for society as a whole. Regarding exchanges of IPRs, cartelization is the main cause of possible negative externalities that is why antitrust authorities have long been very cautious with patent pools and other CROs.

²⁹¹ About the US antitrust policy see US Department of Justice and Federal Trade Commission, *Antitrust Guidelines for the Licensing of Intellectual Property-1995*, 4 TRADE REG. REP. (CCH) 13, 132 (Apr. 11, 1995). As to the European policy, see Valentine Korah (2006), *Intellectual Property Rights and the EC Competition Rules*, Oxford: Hart Publishing

²⁹² Jerome H. Reichman & Tracy Lewis (2005) "Using Liability Rules..." and Jerome H. Reichman (2000), "Of Green Tulips..."

organization would be higher if the initial entitlement (the default rule) was a liability rule rather than a property rule.

Conclusion and Future Developments

Synthesis

This dissertation started with two observations. First, the current property regime of genetic resources and the ongoing debate on the protection of traditional knowledge do not provide satisfying answers. Second, these two issues –genetic resources and traditional knowledge – both concern knowledge, its production, its conservation and its use. In order to shed some light on these issues, I turned to the branch of law that typically regulates the production and the use of knowledge: intellectual property law. In this first part of the dissertation, I reconstructed a history of the evolution of the intellectual property regime – with a special emphasis on patent and biotechnology – trying to identify factors of legal change, unanticipated problems and attempted solutions. Similar factors of change, problems and solutions could be present in both the current genetic resources regime and a potential regime for traditional knowledge. However, international negotiators and commentators often ignore these solutions.

To reconstruct a history of the intellectual property regime, I started with the presentation of the notion of knowledge and its public good dimension. As knowledge is a non-exclusive good, there is a need for a legal mechanism that enables knowledge producers to restrict access to the knowledge produced in order to appropriate the benefits of their investment. Knowledge, however, is a non-rival good which suggests that it should be freely available to ensure its efficient use (Chapter One). These contradictory implications of knowledge characteristics create the knowledge dilemma that was often resolved by a two-part balance. First, R&D, the activity of knowledge production, is undertaken by two modes of production. Basic research is mainly government-funded and its results are open-access; applied research is mainly funded through revenues from IPRs and is carried out by the private sector. Second, within private sector research, the right level of protection must be identified. Therefore, the thresholds for protection can be seen as a means to ensure that access to knowledge is not unduly restricted while knowledge producers have sufficient incentives (Chapter Two).

After having presented this point of departure, I identified some changes in the law of intellectual property that modified the two-part balance. To explain the evolution of IP law, I examined two engines of change. First,

technological change or change in the innovation process can modify the costs and benefits of creating or enforcing intellectual property rights and can lead to developments in patent offices, the Courts, and even statutory law. Second, change in a country's innovation policy can also lead to modifications of intellectual property law (Chapter Three).

I further explained that these changes have led to unanticipated problems. First, the proliferation of IPRs and the resulting need to license a large numbers of patents in order to develop a new product or even to conduct research. This can hinder innovation as trading IPRS implies high transaction costs. Second, the patenting of public research runs counter to a series of social norms that rule exchanges of knowledge and research material in academia and are vital for the advancement of science (Chapter Four).

From a theoretical point of view, these unanticipated problems require intellectual property scholars to take into consideration IPRs exchanges and transaction costs. This has led some scholars to integrate existing theories, such as the notions of property rules and liability rules identified by Calabresi and Melamed and the role of institutions in the reduction of transactions costs analyzed by new institutional economists, into IP scholarship. From a practical point of view, I then analyzed some solutions developed by the government and economic agents.

One possible solution to overcome the limits of the market in coordinating exchanges of IPRs is to resort to government intervention to reduce transaction costs. This consists of replacing exclusive rights by liability rules –statutory or compulsory licenses. Liability rules have three main characteristics: 1) the absence of necessary permission from the holder, (2) a principle of *ex post* compensation, and (3) a mechanism of collective valuation which suppresses the need to obtain the consent of the rights holder in order to access the protected knowledge, and the existence of a collective valuation mechanism that replaces bilateral negotiations. In terms of transaction costs, the advantage of a liability rule lies in the possible reduction of bargaining costs (Chapter Five).

A second and possibly more efficient solution lies in the capacity of economic agents to self-regulate and resort to coordination mechanisms that are more complex than the market. Economic agents can overcome the limits of the market by resorting to property rights and contracts to set up institutional arrangements. This is done in so as to reduce transaction costs or formalize social norms (in order to better enforce them and avoid internal and external defections). An additional

characteristic of these institutional arrangements is that they create some form of intermediary property regimes (common property) in addition to the two classical extremes: individual property and open-access.

Future Developments

Self-regulation and collective rights organizations do not automatically emerge each time they could potentially be useful. Therefore, one important theme on the agenda for future intellectual property research may be to better understand when and how government (law) could facilitate the emergence of these collective rights organizations.

Using this first part as an analytical framework, next I will analyze a genetic resource property regime that regulates the control and exchange of genetic resources. I will write a parallel history of the evolution of this regime, identify a similar departure, parallel legal changes, comparable unanticipated problems and related attempts at solutions.

Later, I will also use those themes to analyze the ongoing discussion about a possible protective regime for traditional knowledge.

Part Two:
The Property Regime of Genetic Resources

Introduction

The objective of Part Two of this dissertation is to provide a better understanding of the genetic resources property regime and how it evolved. In order to reconstruct the history of this regime, I employ the same theories I introduced in Part One.

In the first chapter, I introduce the notions of biodiversity and genetic resources. Genetic resources can be seen as knowledge goods; they enter into a chain of innovation as a part of biodiversity and end up reconfigured as a new drug or crop. As knowledge goods, genetic resources face the public goods problem. However, the public goods problem is slightly different depending on the applicable stage of the innovation chain. On the upstream end of the innovation chain, knowledge (biodiversity) exists but has to be conserved; whereas on the downstream side, new knowledge must be produced by research and development (R&D) efforts.

In the second chapter, I describe the progressive emergence of a first equilibrium. The first element of this equilibrium consists of creating a specific intellectual property right – plant breeders' right. Plant breeder's rights enable the development of a private R&D effort in plant breeding. They also protect innovations (plant varieties) but the genetic resources they contain are left in open-access. The second element is the public funding of genetic resource conservation complemented by some agricultural R&D for developing countries. The last element lies in the legal notions of the Common Heritage of Mankind and the International Undertaking on Phytogenetic Resources. These provide an inclusive regime for genetic resources considered to be the basic material of agricultural R&D, and must therefore be left in the public domain.

In the third chapter, I analyze how this equilibrium will be contested by a two-part change. First, downstream of the innovation chain, the development of modern biotechnologies will modify the costs and benefits of creating IPRs on genetic resources. The possibility of patenting the fruits of modern biotechnology is reconsidered. Once the patenting of living organism is admitted, the coexistence of two systems of protections –patent and plant breeders' right- causes some difficulty, which has led to a revision of the UPOV²⁹³ Convention. Finally, the

²⁹³ UPOV is the French acronym for Union pour la Protection des Obtentions Végétales, i.e. Union for the protection of plant breeders' rights.

TRIPS Agreement will extend to all WTO members the choice of patenting living organisms.

Second, on the upstream side of the innovation chain, traditional farmers and biodiverse countries will claim control over their genetic resources and require compensation for access. These legal changes, both downstream and upstream of the innovation chain, put an end to open-access and provide an atmosphere for the Convention on Biological Diversity ("CBD") that relies on exclusive rights to regulate genetic resources.

In the fourth chapter, I present the CBD and assess its first years of implementation. After presenting the text of the CBD and its main provisions on access to genetic resources and benefit sharing, I observe the process of national implementation of the Convention, using the case of the Philippines as an illustration. Then, I assess, provisionally, the CBD and national legislation on access to genetic resources and benefit sharing (ABS), looking first at the situation in Philippines and then drawing general observations in terms of transaction costs. Finally, I mention a few adopted or considered changes that aim at improving the CBD regime without modifying its logic.

Negotiators of the CBD and drafters of national ABS legislation primarily have the pharmaceutical R&D community in mind when they frame access to genetic resources and benefit sharing. In the fifth chapter, I analyze the reaction of the agricultural R&D community. This community does not consider the CBD regime to correspond with its activities. Therefore, the community has created its own regime that works within the legal framework set up by the CBD, while completely modifying its logic.

I then examine the extent to which the solutions observed in Part One have been used to overcome transaction costs and take into account the norms of open-access and reciprocity in this community. First, I examine how the International Treaty on Plant Genetic Resources includes devices that can be analyzed in terms of liability rules and collective rights organizations attempting to reduce transaction costs and maintain social norms. Second, I observe how the international treaty creates intermediary forms of property between the two extremes, exclusive rights, and public domain. Finally, I use Elinor Ostrom's work to examine the process of emergence of the Treaty (institutional change) as well as the likely resilience of the regime it creates (design principles).

1. Biodiversity as Knowledge: a Double Public Goods Issue

1.1 *The Notion of Biodiversity*

According to the Convention on Biological Diversity (CBD), the expression "Biological diversity" or "Biodiversity" designates the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity, within species, between species and of ecosystems.²⁹⁴ Biologists regard biodiversity as the natural stock of genetic material within an ecosystem. The number of genes in different organisms varies from about 1000 in bacteria, 10,000 in fungi, up to 100,000 for a mammal and 400,000 for flowering plants. Genes are important because they determine the specific capabilities of a particular organism; they contain the information which determines the particular characteristics of that organism. The greater the variety in the gene pool, the greater the variety of organisms which exist or which will exist in the future.²⁹⁵

The evolution of biodiversity is usually observed at the species level. It is estimated that there are between 5 and 30 million species, and the number of species currently described is between 1.7 and 2 million.²⁹⁶ The evolution of biodiversity is evaluated as a result of the speciation (i.e. the creation of new species) and the extinction of species. The diversity of species and the creation of new species result from the process of radiation, i.e. the process by which a species adapt to a particular environment²⁹⁷ and their consequent expansion into unoccupied niches. Extinction is also a natural process, and fossil records indicate that the natural longevity of any species ranges from 1 to 10 millions years. Current biodiversity is the result of around 4.5

²⁹⁴ Article 2, the text of the Convention on Biological Diversity is available at <http://www.biodiv.org/convention/articles.asp>. (emphasis is mine)

²⁹⁵ Timothy M. Swanson (1997), *Global Action for Biodiversity. An International Framework for Implementing the Convention on Biological Diversity*, Earthscan, London, p. 7, hereafter Timothy M. Swanson (1997), *Global Action for Biodiversity...*

²⁹⁶ Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: Biodiversity Synthesis*. Washington: World Resources Institute

²⁹⁷ There is speciation (creation of a new species) when mutant cannot anymore hybridize with old form of the species.

billions years of biological history. During most of this biological history, the rates of speciation and extinction have been approximately equal. The threat to biodiversity arises when the rate of extinction of species exceeds the rate of speciation. In the biological history, there have been at least five periods of mass extinction during which over fifty percent of the animal species became extinct.²⁹⁸ These periods of mass extinction were caused by exogenous shocks to the earth such as extreme volcanic activity or collisions with meteors. But even taking into account those periods of “mass extinction”, the rate of extinction was very low, averaging nine percent per million years, and as such, biodiversity has an extremely slow period of renewal. Before commenting on how the development of human societies has induced an important depletion of biodiversity, it is important to understand that biodiversity is a non-renewable resource. Even if individual biological organisms are renewable resources, the diversity of biological resources is a one-time endowment of the evolutionary process.

1.2 Human Development and Biodiversity Erosion

The previous section briefly explained the concept of biodiversity. This next section will briefly describe the important benefits that biodiversity renders to human societies. First, it must be pointed out that the depletion of biodiversity has generated important benefits for human society.

Indeed, one of the fundamental paths for human development has been the conversion of naturally existing forms to other forms that are more highly valued by humans. Over the past ten thousand years, human societies have reallocated base resources towards a very small selection of species. These are the domesticated and cultivated varieties that have been developed for use in agriculture. Thus, through this conversion process, human societies and their associated species have expanded while reducing the resources available to other species.²⁹⁹ Therefore, the human development process has been closely related with diversity decline over the past ten thousand years.

²⁹⁸ D. Raup (1988) “Diversity Crises in the Geological Past”, in E.O. Wilson (ed.) *Biodiversity*, National Academy Press, Washington D.C.

²⁹⁹ Timothy M. Swanson (1997), *Global Action for Biodiversity...*, p. 11. See also Robert Solow (1974), “The Economics of Resources or the Resources of Economics”, 64 *AMERICAN ECONOMIC REVIEW*, 1-12

Table 1: Increasing Pressures on the Land

Location	Area of arable land & permanent crops in 1000 ha		Percent change
	1961	1996	
Africa	155 272	197 972	27.5
Asia*	436 258	512 475	17.5
Latin America and Caribbean	102 265	161 961	58.4
Oceania	34 789	54 869	57.7
North America	225 709	22 500	-1.4
Europe*	151 365	135 392	-10.6
USSR (former)	239 800	226 158	-5.7
World (developing)	675 567	853 183	26.3
World (developed)	669 894	658 147	-1.8
World (total)	1 345 461	1 511 330	12.3

*not taking into account the relevant part of the former USRR

Source: FAO³⁰⁰

A similar process within agriculture moreover completes this conversion process where a problem of genetic erosion in agricultural species and varieties is also observed. Differences and variations within traditional agricultural practices are being replaced worldwide by uniform modern intensive agricultural practices. Thus, not only have human societies and their associated species developed at the expense of other species, but also agriculture increasingly relies on a diminishing number of species and varieties. So, while thousands of plant species are edible and convenient for human consumption, the majority of the world food is provided by about twenty plant species, and among them the four biggest crops (wheat, rice, maize and potato) take the lion's share. The same is true for animal species where a handful of species (sheep, cattle, goats, pigs) provide most of the terrestrial source-protein. A similar phenomenon occurs within species where one can observe a specialization on a few high-yield varieties.³⁰¹

³⁰⁰ FAO (1998), *Agricultural Land Use*, Rome, FAO

³⁰¹ Timothy M. Swanson (1997), *Global Action for Biodiversity...*, p. 52

Table 2: The Extent of Genetic Uniformity in Selected Crops

Crop	Country	Number of varieties
Rice	Sri Lanka	From 2,000 varieties in 1959 to less than 100 today, 75% descend from a common stock
Rice	Bangladesh	62% varieties descend from a common stock
Rice	Indonesia	74% varieties descend from a common stock
Wheat	USA	50% of crop in 9 varieties
Potato	USA	75% of crop in 4 varieties
Soybeans	USA	50% of crop in 6 varieties

Source: World Conservation Monitoring Center 1992³⁰²

Why is there such a specialization? The answer lies in species-specific learning. To put it simply, progress in agriculture comes from three main factors: tools, chemicals and species-specific learning. With an increasing understanding of the biological nature of a species and of the possibility of influencing it, it is possible to increase the production. Broadly speaking, when over time a group of cultivators have developed knowledge on one species, it is easier for other groups to adopt that species taking advantage of the already existing knowledge rather than constructing equivalent knowledge for other species. Because of the cumulative and non-rival nature of knowledge, and as exchanges between different human societies increase, food production is increasingly concentrated on a few species.³⁰³

In the previous paragraphs, the conversion and specialization processes have been briefly described as well as their link with human development. This link has resulted in a remarkable asymmetry among countries. Indeed, the most developed countries are those that have converted most of their lands and as a consequence they have lost an important part of their biodiversity. Conversely, the biodiversity rich countries are those that have not yet converted their land, and almost without exception they figure among the poorest states.³⁰⁴ Quite logically and legitimately, those unconverted countries that host most of the remaining biodiversity aspire to a higher level of economic development. So far human development has been associated with a conversion

³⁰² World Conservation Monitoring Center (1992), *Global Biodiversity: Status of the Earth's living resources*, Chapman and Hall, London

³⁰³ Timothy M. Swanson (1997), *Global Action for Biodiversity...*, p. 53-54

³⁰⁴ *Ibidem*, p. 54

strategy. If all the unconverted developing countries adopt such a conversion strategy, there would logically be a dramatic depletion in biodiversity. Therefore, we must think about the possibility of dissociating development and conversion, or we must invent alternate means for biodiversity conservation. Before addressing those issues, it is time to explain why biodiversity is useful and worth conserving.

1.3 Biodiversity as Useful Information

One important benefit provided by biodiversity, and the one of most interest in this dissertation, lies in its role as input into the research and development process (R&D) in industries concerned with the regulation of biosphere (e.g. pharmaceutical and agricultural industries). These “bio-industries” can be conceived of as defense systems or dynamic contests between human societies and nature. These industries consist of relentless efforts to struggle against the erosion of human erected defense against a hostile biological world.³⁰⁵ In agriculture, there is a perpetual renewal of the defense system that guards, our food crops against constantly evolving pests and predators. Similarly, in medicine, there are efforts to defend human beings against direct aggressions. In both sectors, our defense efforts are perpetually eroding and must be constantly renewed.³⁰⁶ For instance, in the agricultural sector, the development of a new variety usually takes about 10 years while the developed resistance characteristic is often viable only for 4 or 5 five years. Therefore, a continual breeding effort for new resistance is essential.³⁰⁷ The same is true for the pharmaceutical industry and new medicines.

Biodiversity is an essential ingredient in the defense of the human domain because it contains relevant information. The same forces that are operating against the human domain are also at work against other living organisms. Any life form that survives has developed resistances that are successful in a hostile environment. It is for the retention of these existing resistance strategies of resistance that human societies need biodiversity. In certain cases, biodiversity provides a sort of alternative to the R&D process. For instance, in the use of medicinal

³⁰⁵ Timothy M. Swanson (1996), "The Reliance of Northern Economies on Southern Biodiversity: Biodiversity as Information", 17 *ECOLOGICAL ECONOMICS*, p. 2 hereafter Timothy M. Swanson (1996), "The Reliance of Northern Economies..."

³⁰⁶ *Ibidem*, p. 13

³⁰⁷ Timothy M. Swanson & R.A. Luxmore (1997), *Industrial Reliance on Biodiversity*, World Conservation Press, (WCMC) Cambridge, UK, 98 p

plants, biodiversity provides a solution to a problem. More often, the information provided by biodiversity is a raw informational input into the pharmaceutical and agricultural industries.³⁰⁸ Thus, the primary value of biodiversity lies in its informational content and its utility in the R&D process of those industries.³⁰⁹

Technically, this information can be used in two ways. In the first case, the industry takes notes of the phenotype (i.e. the visible expression of the genes) and makes use of that information to develop new products. This strategy is used by pharmaceutical industries. They screen diverse plants and other life forms in order to detect the presence of chemicals with biological activity. If some information is identified as useful, the pharmaceutical industry will usually make a chemical synthesis of that information. With such a strategy, there is no translocation of the biological material, rather pharmaceutical industry transports the interesting information (successful strategies of resistance) through the chemical replication of the strategy, possibly across vast biological distances (e.g. from a plant to human beings). In the second case, industry observes the genotype (i.e. the nature of the genes possessed by the individual whether they are expressed or not), identifies interesting traits and attempts to transport it to a closely related organism through breeding. Traditionally, this has been the quasi-exclusive strategy pursued by agricultural industries. With such a strategy the interesting information is transported between near relatives using actual genetic material. Recently, the important progress within biotechnology has diminished the technical constraints on the transferability of biodiversity information, which should increase the usefulness and thus the value of that information.³¹⁰

To what extent do bio-industries rely upon biodiversity? In a study about the agricultural industry, it appears that the sources of useful biological information range from the already exploited cultivars to completely wild species. Each year, around six and a half percent of the successful genetic research resulting in a marketed innovation comes from germplasm of unknown species, while eighty-two percent comes from already exploited cultivar. This indicates that every year, the R&D system requires an injection of seven percent new (existing in the nature but unknown hitherto) genetic material. In other words, the stock of

³⁰⁸ Timothy M. Swanson and Timo Goeshl (2000), "Property Rights Issues Involving Plant Genetic Resources: Implications of Ownership for Economic Efficiency", 32 *ECOLOGICAL ECONOMICS* 75-92

³⁰⁹ Timothy M. Swanson (1996), "The Reliance of Northern Economies ...", p. 3

³¹⁰ *Ibidem*, p. 4

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³⁰⁹ Timothy M. Swanson (1996), "The Reliance of Northern Economies ...", p. 3

³¹⁰ *Ibidem*, p. 4

population went back into deep poverty.³¹⁵ Obviously, today, farmers have technological answers to the attacks of nature. However, even in the age of pesticides, herbicides and fertilizers, pathogens may still be able to exploit the specific weaknesses inherited from common parent lines. For example, in 1970 the “corn blight” decimated the corn yield in the United States. Although the pest was only dangerous for a few forms of maize, the maize yields were cut by fifteen percent because ninety percent of corn crop cultivated in the U.S shared genetic material from the same parent line.³¹⁶

In sum, biodiversity provides many different values to human society that could justify conservation efforts. In this dissertation, I focus on information value and insurance value but there are other values for biodiversity.³¹⁷ Nevertheless, information and insurance values provide sufficient arguments for biodiversity conservation. Other types of value can only strengthen the need to conserve biodiversity.

1.4 A Chain of Innovation and Public Good Issues

We have to cope with a chain of innovation for knowledge goods, originating in ecosystems and ending with a final product that is either a new plant variety or a medicine. Often, the chain of innovation is not continuous and linear, but when one has a final product such as a new plant variety or a medicine (downstream), one can always find some biological resources at the upstream end. As the innovation chain concerns knowledge production, it faces the public goods problem. Actually, if the innovation chain is not vertically integrated and different agents operate different stages of the chain, there might be more than one public goods problem. In this case, the public goods problem might be present at each stage of production.

At first, the innovation chain can be divided in two main stages, which can be later subdivided in different stages. In the first stage, we must conserve existing biodiversity; in the second stage, we need to carry out continuing R&D efforts to create new medicines and new crops.

³¹⁵ David S. Tilford (1998), “Saving the Blueprints : The International Legal Regime for Plant Resources”, 30 CASE WESTERN RESERVE JOURNAL OF INTERNATIONAL LAW 373

³¹⁶ Jack R. Kloppenburg jr. and Daniel Lee Kleiman (1988), “Plant Genetic Resources: The Common Bowl”, in Jack R. Kloppenburg Jr. (ed.) *Seeds and Sovereignty, the Use and Control of Plant Genetic Resources*, at 6

³¹⁷ OECD (2002), *Handbook of Biodiversity Valuation : A Guide for Policy Makers*, Paris: OECD

Regarding the first issue, I mentioned that biodiversity provides useful information or knowledge, or in other words, a public good. In this case, the stake is not so much to create new knowledge but rather to conserve an existing and continuously evolving stock of knowledge. However, it does not make a great difference because this stock of knowledge is threatened by erosion and conserving this existing knowledge is just as costly as providing a new one.³¹⁸ Concerning the second issue, it is a classical question of R&D efforts, as was described in the first part of this dissertation.

In both stages, we face the problem of public goods and the knowledge dilemma. Knowledge conservation and production generate a profit that cannot be totally appropriated by the conservator and the inventor, because knowledge is a non-excludable good. A part of the profits are externalized, i.e. captured by others. In the presence of such externalities, the conservator and the inventor anticipate that they will receive less than the social benefit of their effort. In addition, knowledge is not only non-excludable but it is also non-rival and cumulative; the positive externalities of knowledge conservation and production and consequently the difference between the social benefit and the private benefit increase even more. Therefore, it is a typical lack of incentive situation that leads to an insufficient level of private investment. As outlined in the first part of this dissertation, different types of interventions attempt to provide efficient conservation and production of knowledge, but they are confronted by the knowledge dilemma, i.e. only the anticipation of a profit will lead economic agents to invest in the conservation or production of knowledge, but only marginal cost, or no profit, can assure the efficient use of knowledge.

The first possibility is to remedy the public good problem by increasing the degree of appropriability of the return on knowledge conservation or production. If some form of exclusive rights were granted for the conserved or newly produced knowledge, it would enable the conservator or producer to fix a price for its use. In this system, the gain in dynamic efficiency, as result of the greater conservation and innovation activity, is intended to balance out the losses from static inefficiency, i.e. the underutilization of knowledge. The second possibility is the substitution of a public initiative for a private initiative: society is responsible for covering costs of knowledge conservation and production. In this case, the knowledge conservator or producer has no exclusive right, the knowledge conserved or produced belongs to the

³¹⁸ Remember the opportunity cost of not converting lands for conservation purpose.

whole society and a general practice of quick communication and knowledge sharing is expected.

The second part of the dissertation is dedicated to the analysis of how the international community, over the past several decades, has resorted to both possibilities in order to maintain the different stages of the innovation chain. It must be remembered that there are not one, but several public goods provision issues: biodiversity conservation and pharmaceutical and agricultural innovation. Moreover, these issues are more complicated because of their international dimension. Both activities are likely to lead benefits for the entire human community, but they will take place in some countries. There is not one State (Leviathan) and one private agent but a community of states and private agents. It is particularly true for biodiversity conservation. As most of the remaining biodiversity is located in a limited number of developing countries, most of the conservation effort (e.g. not converting land) must be carried out within their territory. For instance, when one of these biodiversity-rich countries makes a land -use decision dedicating some land to biodiversity conservation or converting it to a more productive use, it should take into consideration the value of biodiversity conservation not only for its citizens but also for the human community. We are thus confronted with an international public goods provision issue, where individual states tend to act as private agents in a market and where the community of states must organize to play the role of public authorities.

The next chapter will describe a first equilibrium that resorts to both IPRs and public funding in order to ensure biodiversity conservation and pharmaceutical and agricultural innovation.

2. A First Equilibrium with Three Branches

The issues of conservation and innovation, both considered to be public goods, appear first in the agricultural sector. This explains the predominating role of agronomists and breeders in the design of an initial equilibrium. This equilibrium mixes private and public funding, and combines private property rights, elements of open access and to some extent a common property regime. In the evolution of this property regime, one can identify an initial equilibrium comprised of three branches. The first branch lies in private research activity, encouraged by a *sui generis* intellectual property right. The latter's characteristic consists of protecting new varieties but leaves genetic resources in an open access regime through a breeders' exemption. Moreover, it tolerates farmers re-sowing through farmers' privilege. The second branch lies in the creation and financing of an international network of R&D centers and gene banks that carry out some agricultural innovation and a conservation policy, and place innovation and conservation efforts in open access. This is a case of public provision of public goods. Finally, the third branch lies in the affirmation of a general principle according to which genetic resources are the common heritage of mankind. Under this principle, states must allow access to genetic resources present in their territories. Moreover, the notion of common heritage provides an inclusive regime for genetic resources considered to be the basic materials of agricultural research, which must therefore be placed in the public domain for the use of all mankind.

2.1 Exclusive Rights to Innovation and Genetic Resources in Open Access

The first branch of this equilibrium lies in the progressive development of private research activities, encouraged by a *sui generis* intellectual property right. The latter's characteristic consists of protecting new varieties but leaving genetic resources in open access through a breeders' exemption. Moreover, it tolerates farmers re-sowing through a farmers' privilege.

In the late eighteenth, nineteenth, and twentieth centuries, one observes a growing change in the breeding innovation process that modifies the costs and benefits of creating property rights to foster breeding activity. The development of genetics increases the potential benefits of R&D in

breeding techniques and calls for its autonomy from farming activities. In turn, the development of an independent breeding sector requires some legal intervention both in terms of incentives and regulation. Following this, intellectual obstacles and administrative costs must be overcome. It takes time to identify the precise needs of the breeding sector, to agree on the best-fit solutions and to build the administrative capacity to deal with it.

2.1.1 Technological Context: Plant Breeding Becomes an Independent Economic Sector

The need for a legal framework for agricultural research and development, and more precisely plant R&D, is the result of several technical and social changes: plant improvement or plant breeding has become a scientific activity, deriving its autonomy from farming activities and increasingly carried out by the private sector.

Little is known about how farmers have domesticated and improved wild species for thousands of years. Domestication of plants is an artificial selection process³¹⁹ conducted by humans to produce plants that have fewer undesirable traits than wild plants, and which renders them dependent on artificial (usually enhanced) environments for their continued existence. The practice is estimated to date back 9,000-11,000 years. Many crops in present day cultivation are the result of domestication in ancient times. Today, all of our principal food crops come from domesticated varieties.³²⁰

It is not before the end of the seventeenth century that scientists and landlords were spurred by a real will of methodical crop improvement. During the eighteenth century, experiments were carried out on an empirical basis without real scientific understanding. A few attempts of hybridization were made which gave birth to new varieties, but only for species with asexual reproduction (*Cf. infra*), such as ornamental plants, tuberous plants and fruit trees. Asexual reproduction is a biological process by which an organism creates a genetically similar copy of itself

³¹⁹ There is debate within the scientific community over how the process of domestication works. Some researchers give credit to natural selection, wherein mutations outside of human control make some members of a species more compatible to human cultivation or companionship. Others have shown that carefully controlled selective breeding is responsible for many of the collective changes associated with domestication. These categories are not mutually exclusive and it is likely that natural selection and selective breeding have both played some role in the processes of domestication throughout history. <http://en.wikipedia.org/wiki/Domestication>

³²⁰ http://en.wikipedia.org/wiki/Plant_breeding

without the combination of genetic material from another individual. As for plants, this process is called vegetative reproduction and can take many forms. Some plants, like helms, send up new shoots from their roots, while other species, like potatoes, regenerate from root tubers. Plants with vegetative reproduction can occasionally be sexually reproduced. Thus breeders can succeed in creating new varieties by hybridization and then reproduce genetically similar copies through normal vegetative reproduction. For example, in 1719 Thomas Fairchild created the first artificial hybrid of a carnation and a sweet william, and in 1727, the French Vilmorin Company established a method of breeding sugar beets.

As for sexually reproduced plants (*Cf. infra*), most notably the plants reproduced by grains (angiosperm) such as cereals, it took an extra century to gain some empirical understanding of how parent characteristics are transmitted to their progeny. Sexual reproduction is the second main category of reproductive systems. It involves the organism producing special cells that only contain half the normal number of chromosomes. Thus, these cells contain only half of the genetic material; they are called haploid gametes. The two haploid gametes needed to create a new organism can come from the same organism (self-fertilization) or from different organisms (cross fertilization or out crossing). The majority of angiosperm (e.g. cereals) shows facultative cross-fertilization. They tend to outbreed most of the time, but in some circumstances, they may resort to self-fertilization. So, new varieties can be created by hybridization and then multiplied by man through self-fertilization.

On the theoretical field, In 1866 Mendel published "*Experiments in Plant Hybridization*", invented the notion of gene as unit factor that transmits the hereditary characters, and formulated the laws of inheritance. It was not until the early twentieth century that plant breeders integrated Mendel's findings on the non-random nature of inheritance and the possibility of predicting the frequencies of different types as a result of deliberate crossing.³²¹ The rediscovery of Mendel's findings was followed by a series of findings that fostered plant breeding. In 1908, George Harrison Shull described heterosis, also known as hybrid vigor, i.e. the tendency of the progeny of a specific cross to outperform both parents. By the 1920s, statistical methods were developed to analyze gene action

³²¹ Initially, Mendel's experiments did not gain much attention. They were rediscovered around 1900 by Hugo de Vries, Carl Correns and Erich von Tschermak working on similar problem. They were then popularized by William Bateson who first coined the word "genetics" and founded the Journal of Genetics in 1910.

and distinguish heritable variation from variation caused by the environment.

In practice, plants are crossed to introduce genes from one species into another genetic background. As an illustration, a variety of corn resistant to a specific pest may be crossed with a high-yielding but non-resistant corn variety. The objective is to introduce the resistance without losing the high-yield characteristics. Progeny may then be backcrossed with the high-yielding parent to ensure that the progeny are most like the high-yielding parent. Then, field tests are made to ensure that both yield and resistance characteristics are present.³²² Beyond yield and resistance traits plant breeders also try to introduce characteristics such as tolerance to environmental pressures (drought, extreme temperature, salinity), to pests and herbicides.

In total, during the first decades of the twentieth century, breeders have had at their disposal the tools to create technical and scientific breeding activity that became one of the leading factors in a continual increase in agricultural yields. While during the nineteenth century breeding was still a non-profit activity limited to a few enthusiasts and carried out on the fringes of their production activity, breeding left the domain of agriculture and progressively became its own independent economic sector.

2.1.2 The Long Way towards Plant Variety Protection

The emergence of this new economic sector demands legal supervision. There are two distinct dimensions in the need for legal supervision but in a first stage they are confused.³²³ The first aspect concerns the protection of farmers, i.e. seeds users. Farmers no longer produce their own seeds. Because Farmers can only assess the quality of seeds after a harvest, they need information on the quality of seeds before they purchase them and protection against dishonest sellers. The second aspect concerns *ex ante* incentives for innovations in plant breeding. There are at least three reasons why plant breeders need a device to obtain a return on their investment: (1) the breeding activity has become an autonomous economical sector, (2) the creation of new varieties is a long and costly

³²² http://en.wikipedia.org/wiki/Plant_breeding

³²³ Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques exclusivisme et échanges au fil du temps" in Marie Angèle Hermitte et Philippe Khan (eds.) *Les ressources génétiques végétales et le droit dans les rapports Nord-Sud*, Bruxelles, Bruylant, p. 21 hereafter Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques..."

process,³²⁴ and (3) new plant varieties can readily be copied by free riders (farmers or rival breeders). Because of confusion between these two aspects, the first protection breeders will obtain resembles a trademark. Then, after long discussions on the possibility or the interest of patent protection, farmers obtain a *sui generis* right that shares some features with copyright.

2.1.2.1 Product License Approach

The first government intervention in seed trade concerns users' protection and resembles a product license. In France, agricultural stations were set up as early as 1884 to check the quality of seeds, their homogeneity and their correspondence to their denomination. This first step was enhanced in 1905 by a law on the repression of fraud in seeds trade. After the First World War, an influx of new varieties was proposed to farmers. Most of them disappeared quickly and only the most successful ones survived. Moreover, there was some confusion with the name of the varieties, as there were some single varieties being called several different names. To bring some order in this market, two decrees were issued in 1922 and 1925 announcing the creation of a nomenclature of varieties and a monitoring authority. Decades later, variety catalogues were created. In Germany, the evolution was similar. A system of seeds control was created in 1895 by the farmers union. In 1905 a registry of varieties³²⁵ and an official system of seeds monitoring was set up. These measures contributed to instituting some order in the seed trade and gave some protection to users. These measures did not, however, answer the question of breeder's remuneration.

These measures were not useless for breeder's protection because they brought new notions that were useful for subsequent intellectual property protection. Indeed, the creation of catalogues of varieties led to a clearer legal definition of what constitutes a seed variety. In order to be legally considered a variety, a variety must be distinct and homogenous (uniform). Similarly, to remain in the catalogue, a variety must remain stable over generations; the contrary would be cumbersome for farmers and would hinder breeders' work. As observed by the French Professor M.A. Hermitte, the technical issue –homogenous and stable varieties are more efficient than heterogeneous farmers' varieties – concurs with the economic and legal logic according to which it is easier to sell and then

³²⁴ From 8 to 10 years for annual species and 15 and more for perennial species

³²⁵ Actually, this system also confers to breeders the right to control the two first generations obtained by multiplication. However this right had little effect as when a new variety is created a large number of multiplications is required to create enough seeds for sale.

define property rights on well defined objects. Thus, the mechanisms of seed trade controls constitute the conceptual beginning of intellectual property protection for breeders, identifying the object of protection – a variety – and the conditions for protection – distinctness, homogeneity (uniformity), and stability.³²⁶ Before obtaining such protection, attempts were first made to resort to trademark law.

2.1.2.2 Trademark Law Approach

As I have just mentioned, the preliminary efforts to distinguish, catalogue, and denominate new varieties come from the observation that the source of the problem is the inability of growers to distinguish one plant breeder's seeds from those of competitors. It is therefore tempting to consider breeders' protection through trademark law. Indeed trademark law provides incentives for product differentiation. Trademark law differs from patent and copyright, as it does not confer exclusive rights on an invention or a work. Rather, it confers an exclusive right on the use of a brand name or symbol associated with a product and/or service. Trademarks are used to inform the consumer as to the quality of goods and/or services. The value of a trademark comes from its reputation for quality and depends on the firm's investments in product quality and advertising. Once the reputation is created, the firms can expect a double benefit, first an increase in sales because of repeated purchases and a growing number of purchasers, and second consumers are usually ready to pay a higher price in exchange for saving search costs and an assurance of consistent quality.³²⁷

Indeed, in the United-States, one of the earliest intellectual property measures devoted specifically to plants takes a trademark approach. A legislative proposal introduced in 1906³²⁸ suggested affording breeders the opportunity to register the name of their new variety and to secure for twenty-years the exclusive right to propagate it for sale under the registered name. This proposal, however, was never enacted.³²⁹ In

³²⁶ Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques..." p. 20-21

³²⁷ William M. Landes & Richard A. Posner (2003), *The Economic Structure of Intellectual Property Law*..., chapter 7 "The Economics of Trademark Law".

³²⁸ A Bill to Amend the Laws of the United States Relating to the Registration of Trademarks, H.R. 13570, 59th Cong. (1906)

³²⁹ Mark D. Janis & Jay P. Kesan (2002), "U.S. Plant Variety Protection: Sound and Fury...?", 39 HOUSTON LAW REVIEW 727, p. 731 hereafter Janis & Kesan (2002) "U.S. Plant Variety Protection..."

Germany, some breeders obtained trademark protection but such protection was prohibited in 1920.³³⁰ In France, breeders resorted to a combination of trademark law and variety denomination. All plant varieties were to be sold with a denomination that had to have been mentioned in any transaction. In principle, the denomination of a variety could not be appropriated; everyone was authorized to produce the same variety. However with the use of trademark law, some breeders managed to appropriate a denomination and in so doing obtain a form of monopoly on the sale of the variety's seeds.^{331&332} Nevertheless, the problem extends beyond product differentiation and it is not the case that trademark law, when available, provides sufficient incentive to invest in breeding innovation.

From then, the two issues of consumer (farmer) protection through product licenses and the encouragement of innovation by means of intellectual property rights are clearly separated. In the following paragraphs, I only focus on the second issue. Breeders naturally consider the option of claiming patent protection. Nevertheless, there are some obstacles to plant patentability, and for various reasons, it is felt that the patent system is an inappropriate method of protecting new plants. The obstacles to patentability were first defeated in the United States.³³³ The first steps to overcome the inadequacy of patent protection through the creation of a *sui generis* breeder's right were taken in Europe.³³⁴

2.1.2.3 Obstacles to Patentability

First, there are some economic and evidential preoccupations. According to patent law, the farmer who saves a part of his harvest in order to use

³³⁰ Henri Feyt (2001), « La protection de la propriété intellectuelle des obtentions végétales : Genèse et rapide historique de la mise en place des droits », Colloque les brevets dans l'histoire : Propriété industrielle, historique et économique, Paris, Sorbonne 1-2 October, p. 6

³³¹ *Ibidem*, p.7

³³² In Italy, breeders obtain some protection for some species through contract with users. In United Kingdom, there is no debate on breeders' rights before the *Report of the Committee on the Transaction in Seeds* in 1960 because there is quasi no private breeding activity for major crops, most of it is carried out by the public sector or foreign breeders.

³³³ In the United-States within weeks of the failed effort to use trademark system to create an incentive structure for plant breeders, the same Representative Allen tried introducing a bill to amend the utility patent statute to allow plant patenting. This bill and a few others are defeated in the early 1900s until the adoption of the Plant Patent Act in 1930. See D. Janis & Jay P. Kesan (2002), "U.S. Plant Variety Protection ..."

³³⁴ In Germany, after the prohibition of trademark protection, some breeders obtain patents, but this protection appears little adequate.

it as seeds for the following season is considered to be a counterfeiter. At the time, it seems absurd to require a farmer to pay in order to resow seeds derived from his own harvest. Besides, it is very difficult to prove or document circumstances where a farmer conserves his harvest to use as seeds. Moreover, politicians are worried about a possible raise of the agricultural production costs.

A second category of objections focuses on non-compliance with patent law requirements.³³⁵ Remember that the requirements for patentability are: invention, novelty, inventive step, industrial applicability and adequate disclosure in Europe; novelty, non-obviousness, utility and adequate disclosures are the requirements in the United States. It is contended that breeders' products are not inventions, i.e. the result of a creative process, but rather products of nature or discoveries and therefore cannot be patented.³³⁶ For similar reasons, it is sometimes also argued that plants cannot comply with the novelty requirement. Similarly, it is also contended that plant varieties do not involve an inventive step (non-obviousness condition) as the breeding processes are quite obvious having regard to the state of the art.

Two further objections relate to the subject matter. It is argued that patent law has been tailored for inanimate objects and not living organisms. In the same vein, some commentators interpret the industrial applicability condition as excluding agricultural products.

One of the most serious objections raised against plant patenting is that new plants and their breeding processes are unamenable to the statutory requirement of written description. In the same vein, the non-reproductibility impediment³³⁷ is raised. Although not literally present in

³³⁵ For a detailed study of these impediments, legal doctrine and case law references see Geertrui Vanoverwalle (1999), "Patent Protection for Plants: A comparison of American and European Approaches", 39 IDEA-JOURNAL OF LAW AND TECHNOLOGY 143. See also Geertrui Vanoverwalle (1996), *Octrooierbaarheid van Plantenbiotechnologische Uitvindingen. Patentability of Plant Biotechnological Inventions*, Bruylant, Brussels or Linda J. Demaine & Aeon Xavier Fellmeth (2002) "Reinventing the Double Helix: A Novel and Nonobvious Reconceptualization of the Biotechnology Patent" 55 STANFORD LAW REVIEW 303 at 330-387

³³⁶ In US Case law see for instance *American Wood-Paper Co. v. Fibre Disintegrating Co.*, 90 U.S. (23 Wall.) 566 (1874) or *Cochrane v. Badische Anilin & Soda Fabrik*, 111 U.S. 293 (1884)

³³⁷ When a new variety is created after crossing two existing varieties (sexual reproduction), obtaining a same plant through the same process is hazardous as in sexual reproduction, for the most it is the hazard that determines what characteristics the progeny will take from each of the parents. However, with a minimum of flexibility, the objection can be dismissed. Indeed, once obtained through outcrossing, the new

patent acts, the reproductibility requirement stems from the obligation to provide an enabling-disclosure in the U.S law and from the industrial applicability requirement in Europe. In broad outline, it is argued that a person skilled in the art should always be able to repeat the process of making a new plant. Whereas plants spread by natural multiplication, without necessary repetition of the breeding process which created them. Sometimes, this process is no longer available. The issue is thus whether a description of the breeding process is required or whether a description of a mode of reproduction is sufficient.

Later most of these objections will be easily dismissed but three of them maintain some importance and will shape the future protection: the difficulty of description, the fact that identification of new plant varieties looks closer to discoveries than inventions, and the fact that breeding processes are quite obvious and that all breeders use the same ones.

2.1.2.4 The U.S. Plant Patent Act

In 1930, the U.S. Congress enacts the Townsend-Purnell Plant Patent Act³³⁸ creating a patent regime for asexually reproduced plants. The Plant Patent Act had a three-part contribution. In the short term, it provided limited protection; in the long term it laid the groundwork for the patentability of plants, which occurred in the 1980s; and in the medium term, it suggested that a *sui generis* right could be more adequate. Actually, the Plant Patent Act met some obstacles to plant patentability in dismissing them and affirming the patentability of plants, but also in seriously limiting the subject and scope of protection.

The Plant Patent Act provides that:

"Whoever invents or discovers and asexually reproduces any distinct and new variety of plant, including cultivated sports, mutants, hybrids, and newly found seedlings, other than a tuber propagated plant or a plant found in an uncultivated state, may obtain a patent therefor, subject to the conditions and requirements of title.

The provisions of this title relating to patents for inventions shall apply to patents for plants, except as otherwise provided."

First, the requirement of sexual reproduction draws the line between what can be protected and what is excluded from protection. The

variety can be asexually reproduced, providing perfect copies. (*cf. infra* the plant patent act)

³³⁸ 35 U.S.C. §§ 161-164, Commonly referred as Plant Patent Act

protected subject matter is plant variety asexually reproduced; this limitation excludes seed reproduced plants (e.g. cereals) from protection. This limitation is as much due to the characteristics of asexual reproduction as it is to economic and political considerations. Neither the U.S. Congress, nor the agricultural sectors were ready in the 1930s to grant patent for plants with such economic importance.³³⁹ For the same reasons, the Act explicitly excludes tuber propagated plants (i.e. potatoes and Jerusalem artichoke) from protection. Thus, the protection was limited to the nursery industry (ornamentals and fruit) where the lack of appropriation lays in competition from other nurserymen, not farmers.³⁴⁰

Second, the requirement of asexual reproduction also greatly narrows the scope of protection. It is only the fact of cloning the patented plant (making a perfect copy with the same genotype³⁴¹) that infringes the plant patent. Consequently, the term “variety” as used in the Plant Patent Act, must be understood to encompass a single, individual plant. Infringement of a plant patent is extremely limited, requiring an actual physical taking from the patented plant.³⁴² Actually, the U.S. Plant Patent Act only exerted a limited practical impact as the protection offered by plant patents was seriously limited both in terms of subject of protection and scope of protection.

Third, the Plant Patent Act constituted a first step towards the protection of breeding innovation through intellectual property while dismissing some obstacles to plant patentability. In itself, the Act dismissed the argument that living organisms cannot be patented, and introduced an exception to the U.S. Patent Act, which characterizes patentable subject matter in terms of processes, machines, manufactures, or composition of matter.³⁴³ Also, the term “discovers” overcame the objection that plants are discoveries or products of nature. Moreover, the requirement of asexual reproduction was an additional answer to the objection that plants are discoveries or products of nature because reproduction often requires human intervention. Eventually, the requirement also overcame the reproductibility objection, as asexually reproduced plants are perfect copies of the original.

³³⁹ Mark D. Janis, & Jay P. Kesan (2002), “U.S. Plant Variety Protection: ...”, p. 736. See also Cary Fowler (2000), “The Plant Patent Act of 1930: A Sociological History of its Creation”, 82 JOURNAL OF PATENT & TRADEMARK OFFICES SOCIETY 621

³⁴⁰ *Ibidem*

³⁴¹ Having the same essential characteristics as the protected plant is not sufficient to constitute infringement.

³⁴² *Imazio Nursery, Inc. v. Dania Greenhouses*, 69 F.3d 1560, 1568 (Fed. Cir. 1995)

³⁴³ 35 U.S.C. §101

Because this protection was circumscribed both in subject matter and in scope and limited to the United States, breeders' struggle for intellectual property protection continued.³⁴⁴ The next initiative came from the other side of the Atlantic. The European initiative deemed patent protection inadequate and envisaged the drafting of a *sui generis* right.

2.1.2.5 Inadequacy of Patent Law

The subject matter that breeders want to protect is the object they sell to farmers, i.e. a new variety. The identification of "variety" as the subject matter of protection has several implications in the design of a law for protection. The breeding activity is not made up of discrete innovations; rather it is a cumulative process whereby today's invention is built on yesterday's innovation. In broad outline, a new variety is made up of two elements: a new element that induces a variation compared with existing varieties, and an old element, i.e. a variety already existing to which the new element has been combined. In patent law the protection is limited to the new element; what breeders want to protect, however, is not the new element, but rather the whole variety. On the other hand, as the new variety will, in its turn, serve as a base for yet-to-be identified varieties, it is deemed important to allow open-access to the invention because it is a source for a new invention. This is not possible in patent law where the inventor who incorporates a patented invention into his own invention must obtain the consent of the patentee and pay royalties. Consequently, the desire of plant breeders may appear to be a little contradictory. Breeders want property rights not only on the new element but on the whole variety, while at the same time they want an open-access regime, not only to the old element but also to the whole variety. In fact, as noted by Professor Hermitte, in breeders' minds, the same variety has two functions and should be submitted to two property regimes. The variety is a final product sold to farmers, and as such it should be protected; the variety is also research material, and as such it should remain in open-access.³⁴⁵ Another way to distinguish the two roles of plant varieties – final product and source of innovation – is to distinguish

³⁴⁴ Nevertheless, 2700 plant patents were issued under the Plant Patent Act between 1930 and 1970. See David G. Scalise & Daniel Nugent (1995), "International Intellectual Property Protections for Living Matter: Biotechnology, Multinational Conventions and the Exception for Agriculture", 27 CASE WESTERN RESERVE JOURNAL OF INTERNATIONAL LAW 83

³⁴⁵ Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques..." pp. 21-22

varieties and genetic resources. Plant varieties are protected while the genetic resources they contain remain in open-access.

2.1.2.6 The International Convention for the Protection of New Varieties of Plants³⁴⁶ (“UPOV”)

In the late 1930s, the development of plant breeding, the first attempts for protection and the inadequacy of patent law produced a consensus on the following elements: (1) a *sui generis* system of protection was needed; (2) the subject matter of protection must be the variety; (3) access to the protected variety must be given to breeders for breeding purposes. In 1938, the ASSINSEL (Breeders Association for the Protection of Plant Varieties)³⁴⁷ was founded. After the interruption of the war, the first step came from Germany where a Seeds Act³⁴⁸ was enacted in 1953. Then in 1957, France took the initiative to convene an *International Conference for the Protection of Plant Varieties* which set up an expert committee in charge of proposing an international convention. The text of the UPOV Convention³⁴⁹, inspired by the German law, was adopted at the second session of the conference in 1961. It was initially signed by France, Germany and the Benelux countries, and was signed the following year by the United Kingdom, Denmark and Switzerland.³⁵⁰ The UPOV Convention came into force on August 10, 1968, and was slightly modified in 1972, 1978 and with more extensive modifications in 1991. By April 2006, UPOV membership had swelled to 61 members. Most notably, the United States completed their Plant Patent Act by the Plant Variety Patent Act in 1970³⁵¹ that for the most was inspired by the UPOV Convention. This American legislation led to their adhesion to UPOV in 1981.

³⁴⁶ The texts of the successive version of the convention can be founded at the UPOV website at the following address:

<http://www.upov.int/en/publications/conventions/index.html>

³⁴⁷ ASSINSEL is the French acronym of Association Internationale des Sélectionneurs pour la protection des obtentions végétales

³⁴⁸ For an English translation of the German law see “Patents. Law concerning Protection of the Seed of Cultivated Plants” 54 PATENT & TRADEMARK REVIEW 358-66 (1956)

³⁴⁹ UPOV is the French acronym of Union pour la Protection des Obtentions Végétales, i.e. Union for the Protection of new Varieties of Plant

³⁵⁰ For a detailed record of the different conference, see Anne-Marie Flury-Jeker (1987), *La protection juridique des obtentions végétales*, Editions Ides et Calendes, Neuchâtel, Switzerland.

³⁵¹ 7 U.S.C §§ 2321-2583 (2000)

Regarding the content of the UPOV Convention, it first sets the principle of plant variety protection through intellectual property rights. It gives members states the choice between two types of protection: patent or breeder's right³⁵² but requires that these rights be mutually exclusive in that no one country can offer both rights.³⁵³ The rest of the UPOV Convention relates to the creation of the new *sui generis* right.

Requirements for Protection

As hoped for by breeders, the protected subject matter under the UPOV Convention is a discrete plant "variety." There are four substantive requirements for protection: the variety must be new, clearly distinguishable,³⁵⁴ sufficiently homogenous or uniform³⁵⁵, and stable in its essential characteristics³⁵⁶. Similar to patent protection and most intellectual property rights, the variety must be "new". The condition of distinctiveness is closest to the novelty requirement and on close examination looks like a definition of novelty rather than an extra requirement. Indeed, Article 6(1)(a) provides that the *new variety must be clearly distinguishable by one or more important characteristics from any other variety whose existence is a matter of common knowledge at the time when protection is applied for*. The same article adds that the protection is available *whatever may be the origin, artificial or natural, of the initial variation from which it has resulted*. The variety must be homogenous or uniform. Homogeneity is an ingredient in the definition of variety, rather than being an extra condition. A sufficient level of homogeneity is necessary to identify and distinguish a new variety. As total homogeneity does not exist, some tolerance is admitted but the number of aberrant plants, i.e. plants differing from the description of the variety, must be limited.³⁵⁷ For the same reasons, the variety must be stable. Genetic stability is also an integral part of the notion of variety. The variety must continue to

³⁵² 1961 UPOV, article 2 (1)

³⁵³ The prohibition of the double protection will be removed in the 1991 revision.

³⁵⁴ 1961 UPOV, article 6 (1) (a)

³⁵⁵ 1961 UPOV, article 6 (1) (c). The condition of homogeneity is replaced by a condition of uniformity in UPOV 1991 with no change in the meaning. That is why the protectability requirements are often referred by the acronym "DUS": distinction, uniformity and stability.

³⁵⁶ 1961 UPOV, article 6 (1) (d) that is to say, it must remain true to its description after repeat reproduction or propagation

³⁵⁷ See Anne-Marie Flury-Jeker (1987), *La protection juridique des obtentions végétales*, Editions Ides et Calendes, Neuchâtel, Switzerland, p. 131

conform to its definition after each multiplication. All in all, there is less to say about these requirements³⁵⁸ than about what is not required.

The major difference with patent law lies in the absence of a counterpart to the requirement of inventiveness (non-obviousness). Under patent law an invention must involve an inventive step that, with regard to the state of the art, is not obvious for a person skilled in the art. The *raison d'être* of this requirement is that patents are deemed to be unnecessary for small-scale improvements that are within the reach of those working in this sector. For these small-scale innovations, the social cost of granting a patent (restricting access) is presumed to exceed the benefits of its incentive effect. On the contrary, in the UPOV regime, there is no concern about the process and the scale of inventions. Plant varieties that are simply discovered can be protected. In addition, breeding processes cannot be protected. This is due to the nature of these breeding processes; there are few, they are well known and there is little substitution. Consequently, it would be of little sense to require a high degree of inventiveness, and it is essential to leave processes in open access.³⁵⁹

Scope of Protection and Limitations of Protection

Like every intellectual property right, the breeders' right is a temporary exclusive right. The breeder has an exclusive right on the production for reproduction purposes, and on the offering for sale and marketing of the variety.³⁶⁰ However, as hoped for by breeders, the exclusive rights under the UPOV regime are subject to limitations and exceptions that extend well beyond those found in patent law. The breeders' right includes a provision exempting from infringement the utilization of the new variety as an initial source of variation for the purpose of creating another varieties and the marketing of such varieties.³⁶¹ This essential provision, often called the *breeder's exception*, extends beyond research exceptions that may exist in the European patent laws. Open access to the variety is not limited to the research phase but also applies to the marketing of the

³⁵⁸ However these requirements, especially homogeneity, will later be subject to criticism for reinforcing trends towards genetic uniformity, thus leading to a higher degree of genetic vulnerability. See Gary Fowler and Pat Mooney (1990) *Shattering. Food, Politics and the Loss of Genetic Diversity*, University of Arizona Press, Tucson, and Crucible Group (1994), *People, Plants, and Patents*, International Development Research Centre, Ottawa, Canada.

³⁵⁹ Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques...", p. 25

³⁶⁰ 1961 UPOV, article 5 (1)

³⁶¹ 1961 UPOV, article 5 (3)

new variety.³⁶² Actually, in the UPOV regime, there exists an exclusive right to the variety, but the genetic resources included in the variety – which are the source of the variation – remain in open-access for breeding purposes³⁶³. In addition, contrary to breeders' wishes, breeder's rights are also limited by an implicit *farmer's privilege*, which allows farmers who grow protected varieties to save the resulting seeds for the production of a subsequent crop. The text of the Convention is silent on this issue, but at the time, this old practice was not called into question.

Ending this brief presentation of the breeders' right, it is worth mentioning some features it has in common with copyright. When an author has a copyright in a book, there are three goods and three owners. The purchaser owns the physical manifestation of the book, the text or the content belongs to the writer and the ideas presented in the books are in open-access. Similarly, with breeder's rights, the purchaser owns the individual plant, the variety belongs to the breeder and the genetic resources contained in the plant are in open-access.

In this section, I have reported the emergence of a breeding sector fostered by the enactment of intellectual property legislation. However, this is only one branch of the equilibrium. Indeed, northern private agricultural research is not sufficient to assure the food security of mankind and an international conservation policy is necessary to feed the agricultural research appetite for genetic resources.

2.2 The Public Supply of a Double Global Public Good

In this section I explain how it appeared increasingly necessary to complement the R&D effort provided by the breeding sector with an international and publicly funded agricultural research capacity and to initiate an international conservation policy. Thus, the second branch of the equilibrium lies in the public supply of an international network of gene banks and R&D centers, which carry out a conservation policy and part of the agricultural innovation and then place the results of their conservation and innovation efforts in open access.

³⁶² Compare with the Uniform Biological Material Transfer Agreement described in part one in which research use is authorized but an extra authorization is required for the marketing of a new variety

³⁶³ Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques...", pp. 24-25.

2.2.1 Technological Context

2.2.1.1 Genetic Resources: of Old but Growing Importance

The search for plant products has a long history. With precious metals, plants have been an essential objective of European conquest since the second half of the fifteenth century. The Portuguese settled in Asia to secure a monopoly on pepper and species. For similar reasons, Columbus was induced to launch his ships into the Atlantic Ocean; in Cuba he found “*species, cotton, mastic, (...), rhubarb and cinnamon.*” Naturalists and botanists accompany the great military expeditions to collect inventories of potential plant products. At the end of the nineteenth century, the amassing of these inventories becomes methodic and systematic.³⁶⁴ The potential benefits from botanies are not limited to these inventories. Since the end of the eighteenth century, the transfer of plants from one part of the world to the other became a crucial stake in the economic competition among colonial states. European states attempted to introduce exotic species into their own territory to increase and diversify their agricultural production. In addition, colonial powers endeavored to transfer foreign plants into their economic sphere. For instance, at the beginning of the eighteenth century, the Dutch managed to implant coffee in Java and to supplant the Arabian production. Afterwards they were supplanted by the French who succeeded in introducing coffee into Santo-Domingo thus assuring half of the world’s production at the end of the eighteenth century.³⁶⁵ To organize these transfers, botanists and botanic gardens played a leading role. In 1654 the Dutch company of the Indies created the first overseas botanical garden in Cape Town, South Africa. . In the Nineteenth century, plants inventories, transfers and selections intensified and a real world network of 200 botanical gardens was in place.

The United States has a different history but they also depended on many other countries for most of their important crop plants. Very early on, they set up systems of germplasm collections. Official recognition of this work for agricultural development came in 1827 when President John Adams requested all American consuls to send home seeds or plants of promising crops and trees for subsequent distribution by the U.S. Patent Office to American farmers.³⁶⁶ In 1862, the U.S. Department

³⁶⁴ Christophe Bonneuil (2001), “L’empire des plantes”, *COURRIER DE LA PLANÈTE*, vol. 62, p. 6

³⁶⁵ *Ibidem*

³⁶⁶ Robin Pistorius (1997), *Scientists, Plants and Politics. A history of the Plant Genetic Resources Movement*, Roma: IPGRI, p. 4, hereafter Robin Pistorius (1997), *Scientists, Plants and Politics...*

of Agriculture (USDA) was created and six years later the newly founded Seed and Plant Introduction Section of USDA begun promoting the collection and introduction of new crops. An inventory of the new plants was created, listing every plant collected by the USDA that entered the United States. This catalogue was accessible to breeders that could obtain seeds or cuttings. Progressively, the U.S. germplasm system structured itself around a National Seed Storage laboratory in Fort Collins, Colorado and a network of regional centers responsible for the evaluation and regeneration of the species.³⁶⁷

Russia also played a pioneering role in the initiation of collection and conservation policies. In the 1920s, Nikolai Vavilov, in charge of the Soviet Union's Institute of Plant Industry in Leningrad, was convinced that plant breeders should look for "fresh" genetic materials to revive the vigor of cultivated varieties. He suggested that more primitive land races and wild relatives of modern cultivars contain genetic material that could provide some of the environmental tolerance lacking in the cultivated varieties. To access this genetic material, he called for a global inventory of both cultivated plants and their wild relatives and sent expeditions to all parts of the Soviet Union and to sixty other nations. In total, Vavilov established a network of 400 research and experimental centers throughout the Soviet Union, and maintained relations with similar centers in other parts of the world. In addition, Vavilov identified twelve regions of the earth containing a high degree of biological diversity and he suggested that most major food crops originated from these "centers of diversity," located for the most part in developing countries.³⁶⁸

In the context of this growing interest for genetic material, the need to organize international cooperation policies for agricultural R&D and conservation appeared.

2.2.1.2 Agricultural Research for All, an American Initiative

After World War II and the success of the Marshall Plan, the idea of an agricultural technical aid for the benefit of developing countries was in

³⁶⁷ U.S. National Research Council (1993), *Managing Global Genetic resources*, Washington D.C: National Academy Press, p. 34-35; see also E. James (1972) Organization of the United States National Storage Laboratory, in E.H. Roberts (ed), *Viability of Seeds*, London: Chapman & Hall

³⁶⁸ David S. Tilford (1998), "Saving the Blueprints: The International Legal Regimes for Plant Resources", 30 CASE W. RES. J. INT'L L. 373, at 384-385 and Robin Pistorius (1997), *Scientists, Plants and Politics...*, p. 7

the air in the United States.³⁶⁹ Rather than traditional food aid or emergency aid, agronomical research helping to increase the production capacity of developing countries and food security appeared as a sustainable contribution. Moreover, the problems of developing countries, such as pests and diseases, could reach developed countries; it could thus be useful overseas. Additionally, the United States, as well as Northern countries, have constant need of new genetic material; helping developing countries rich in biodiversity, to develop their research capacity provided an opportunity to identify, evaluate and import interesting crops. Finally, during the cold war, fostering the agricultural development of developing countries, notably through the green revolution, was seen as weapon against the seduction of the communist block.³⁷⁰

The first step did not come from the government but from two private foundations: the Rockefeller Foundation and the Ford Foundation. In the 1940s, after preliminary studies, the Rockefeller Foundation launched, in collaboration with the Mexican Ministry of Agriculture, an intensive program of crop improvement, called the Mexican Agricultural Program.³⁷¹ After a decade of collaborative research and training focusing on a few species, important results were reached in reducing food deficits. After this first success, similar programs were launched in the 1950s in Columbia, Chili and India. Worried about food shortages in Asia, the Rockefeller foundation associated itself with the Ford foundation; and in 1959, the two foundations and the government of Philippines founded the International Rice Research Institute (IRRI) that built an international collection of rice varieties and undertook a large breeding program, looking for high-yield varieties. After this first success, the two foundations repeated the project and created a series of similar centers. For example, the Center for the improvement of wheat and maize (CYMMIT) was set up in Mexico. CYMMIT developed maize varieties with high growth, rigid straw, resistance and adaptation to fertilizers. These varieties largely increased the yield not only in Mexico but also in many developing countries, most notably, India, Pakistan and Turkey. The overall success of this handful of International Agronomical

³⁶⁹ Lowell S. Hardin (2001) "Des intérêts bien compris", *COURRIER DE LA PLANÈTE*, vol. 62, p. 27

³⁷⁰ Nicolas Brahy & Selim Louafi (2004) "La Convention sur la diversité biologique à la croisée de quatre discours", *LES RAPPORTS DE L'IDDRI*, n°4, p. 10-12, hereafter Nicolas Brahy & Selim Louafi (2004) "La Convention sur la diversité biologique..."

³⁷¹ Robin Pistorius (1997), *Scientists, Plants and Politics...*, p.5

Research Centers (IARCs) constitutes the golden age of international agricultural research and is often referred to as the green revolution.^{372&373}

After these first developments, the idea of an international agricultural research and development effort went through two important changes. First, increasing attention was given to genetic resources conservation; second, the desire to reproduce the success of the IRRI, CYMMIT and the other first IARCs was out of reach for private foundations, thus implying that the Ford and Rockefeller Foundations should defer to governments.

2.2.2.3 The Need for an International Conservation Policy

In the 1950s and 1960s, the emphasis was on developing germplasm collections for immediate breeding efforts, as conservation was not a major preoccupation. However, the focus increasingly shifted towards conservation as the awareness of genetic erosion was growing. In the USA, the need to prevent genetic erosion was due to mono-cropping with new hybrid varieties. By the late 1950s, 90% of the total maize surface was covered by new hybrids. Action to prevent further loss was called for. The European Society for Research and Plant Breeding (EUCARPIA) made a similar observation. The first international claim for action in conservation particularly for landraces³⁷⁴ and wild relatives³⁷⁵ came during the tenth conference of the Food and Agriculture Organization (FAO) in 1959. It is noted that natural vegetation and primitive cultivated forms was being eliminated by the conversion process (i.e. overgrazing, burning, and clearance for new cultivated land) and specialization (i.e. their replacement by high-yield variety). It was also noted that many existing crops had a narrow genetics base, and that genetic resources from areas of diversity were little exploited. A progressive will to organize an international effort for conservation and use of genetic resource emerged in the international community and the FAO.³⁷⁶

The next steps of this budding conservation effort lay in a few issues: How to conserve? Who will carry on the conservation? And how is

³⁷² Norman Borlaug the central scientific figures of the Green Revolution received the Nobel Peace Prize in 1970

³⁷³ Lowell S. Hardin (2001) "Des intérêts bien compris", *COURRIER DE LA PLANÈTE*, vol. 62, p. 28

³⁷⁴ Landraces are farmer-developed cultivars of crop plants which are adapted to local environmental conditions.

³⁷⁵ Uncultivated relative of crop species

³⁷⁶ Robin Pistorius (1997), *Scientists, Plants and Politics....*, p. 5-16.

conservation to be funded? Those questions have been the subject of numerous founding meetings and controversies. Here, I briefly present their outcomes to the extent that it is necessary to understand the following.³⁷⁷ Once the conservation objective is accepted, there are two different approaches to cope with: *ex situ* and *in situ* conservation. These differ both in their implications for genetic resources conservation and in their impact on land use. *In situ* conservation means that genetic resources exist within ecosystems and natural habitats and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties. On the contrary, *ex situ* conservation refers to conservation outside the original or natural habitat. One of the comparative advantages of *in situ* conservation is that it allows continued evolution of the crop variety under human and environmental selection. In knowledge economics terminology, it can be said that *in situ* conservation is focused on the optimal appropriation of information arriving over time.³⁷⁸ Conversely, in *ex situ* conservation, genetic resources are pulled out of the evolution process; it is focussed on the conservation of existing stocks of useful crop genetic resources. The emphasis is put on the possibilities of immediate uses. For breeders or other users, *ex situ* conservation is the simplest way to find useful genes to work with; breeders can extract genetic traits from storage and transfer them to elite lines. In knowledge economics terms, it can be said that *ex situ* conservation is focused on the optimal utilization of a given germplasm at a given point in time.³⁷⁹ The relative values of these two approaches are still discussed today, but at that time the choice of *ex situ* conservation is made mainly for practical reasons: *in situ* conservation requires large quantities of land, must be organized in a decentralised way and in the zones of diversity. This is the case, for the most part, in developing countries while *ex situ* conservation is cheaper, requires hardly any land, and can be organized in a centralised way and is more immediately useful for breeders.³⁸⁰

Once the choice of *ex situ* conservation made, it must be decided who will carry on this conservation effort and with what funding. These

³⁷⁷ For detailed record see Robin Pistorius (1997), *Scientists, Plants and Politics.*, or Nicolas Brahy & Selim Louafi (2004) "La Convention sur la diversité biologique..."

³⁷⁸ Swanson, Timothy M. & Timo Goesl (1998) "The Management of Genetic Resources for Agriculture: Ecology and Information, Externalities and Policies", CSERGE Working Paper GEC 98-12

³⁷⁹ *Ibidem*

³⁸⁰ For more detail on the choice of *ex situ* conservation see Robin Pistorius (1997), *Scientists, Plants and Politics.*, or Nicolas Brahy and Selim Louafi (2004) "La Convention sur la diversité biologique..."

questions were answered at the same time as, and with a similar solution as, the international agricultural research effort for food security. I briefly present them in the following paragraphs.

2.2.2 The CGIAR Networks: Public Provision of Two Public Goods

2.2.2.1 International Agricultural Research: Creation of the CGIAR

Unprecedented harvests from new varieties of rice and wheat based on research done by the four first IARCs raised hope that this transformation of agriculture practice could be expanded worldwide and gave rise to a demand for the creation of new centers. Increasing the number of centers was out of reach for private foundations and required public funding. In 1971, after two years of negotiation, the World Bank, the United Nations Development Program (UNDP), the Food and Agriculture Organization (FAO), the African and Inter-American Development Banks, as well as a handful of countries –the United States, Canada, Japan, France, United Kingdom and Sweden – agreed to found the Consultative Group on Agricultural Research (CGIAR). Co-sponsored by the World Bank, the FAO and the UNDP, the CGIAR's founding objective was "*to increase the pile of rice*" –in reality food – in tropical countries that faced scarcity. The priority was first given to research on cereals such as rice, maize, wheat and cassava, before being extended to such commodities as chickpea, sorghum, potato, millet and eventually to twenty-seven other commodities.³⁸¹ In order to do so, CGIAR was responsible for the strengthening of the existing IARCS and the creation of a series of new ones in addition to being in charge of ensuring maximum complementarities and coordination of international, regional and national efforts in financing and undertaking agricultural research.³⁸² Since then, the membership of the group has increased to fifty-eight countries and the number of CGIARs centers (IARCS) has grown to sixteen.³⁸³ I mentioned earlier that research and development

³⁸¹ CGIAR, *The CGIAR History* available at www.cgiar.org/who/wwa_history.htm

³⁸² CGIAR, *Resolution on the Objectives, Composition and Organizational Structure*, Washington D.C. May 1971. The text of the resolution is available at <http://www.worldbank.org/html/cgiar/publications/founding.html>

³⁸³ For a list of the International Agricultural Research Centers and a description of their respective activities as well as for a good evaluation of CGIAR's work see Curtis Farrar (2000), "The Consultative Group for International Agricultural Research", Case Study for the UN Vision Project on Global Public Policy Networks, available at <http://www.globalpublicpolicy.net>

(as a knowledge production activity) is a public good. Thus, it can be said that the creation and the funding of the CGIAR and the IARCS constituted an effort of the international community to provide a global public good and to place it at the disposal of the community of states and their citizens.³⁸⁴ In order to provide this public good, the elected option was public funding, which enabled the choice of open-access as a property regime.

2.2.2.2 International Conservation Strategy: a World Network of Genebanks

The CGIAR was not only in charge of providing one public good – agricultural R&D – but was also entrusted with the provision of a second public good –genetic resources conservation.

To answer the threat of genetic erosion and to carry on the *ex situ* conservation effort, it was decided to create a world network of gene banks. After contentious discussions,³⁸⁵ it was decided – notably because of the lack of alternative international infrastructure and funding – to set up a network of national and international genebanks under the supervision of the CGIAR with a coordinating center, the International Board for Plant Genetic Resources (IBPGR).³⁸⁶ The IBPGR was in charge of the collection function. It organized missions to collect genetic resources to increase existing collections. Members of the network assumed the conservation and distribution functions. . Once collected, the resources were entrusted by the IBPGR to a national or a CGIAR gene bank. In legal terms, the network was in the sum of the bilateral relations between the IBPGR and each gene bank. It took the form of a *letter of acceptance* signed by the organizations that received the resources for conservation. The letter of acceptance enumerated the latter obligations: the acceptance of the material, the commitment to dedicate the necessary funds for its conservation and distribution and above all the recognition of the open-access principle.

³⁸⁴ National governments are in charge of setting up large distributions of new seeds to their national farmers.

³⁸⁵ For a record of the pros and cons of this option by comparison with an alternative approach focused on regional genebanks settled in biodiversity rich regions or for more detailed on the competition between the FAO and the CGIAR, see Robin Pistorius (1997), *Scientists, Plants and Politics...* p. 48-68. Or Nicolas Brahy and Selim Louafi (2004) “La Convention sur la diversité biologique...”p. 10-12

³⁸⁶ Now named International Plant Genetic Resources Institute (IPGRI)

Within ten years (from 1974 to 1984), the IBPGR managed to develop a cooperative network of agricultural research centers in about 100 countries, it organized and co-financed about 300 collecting missions in about 90 countries, collecting 120,000 new seeds accessions from 120 species; it provided assistance to developing countries who established national conservation facilities; it established an information system with standard procedures in documentation, recording and storage, etc.³⁸⁷ Today, the CGIAR holds the world's largest collection of plant genetic resources (over 600,000 accessions of more than 3,000 crop, forage, and pasture species) in public trust for the future.

It has been said that genetic resources provide useful information or knowledge, that is to say a public good. As biodiversity is threatened by human development, it is necessary to conserve this existing stock of knowledge. In terms of provision, the establishment of this international network of gene banks is thus a joint-production of a public good by individual states (national gene banks) and the international community (international gene banks). In terms of a property regime, genetic resources conserved in the gene banks network are in open-access.

In sum, the international community has set up and funded two branches of an international network that provides two public goods – part of the agricultural research, and a conservation policy. It remains to provide access to genetic resources present in plants in their natural states and to affirm a formal and general property regime for genetic resources. To this end, an international undertaking on phyto-genetic resources will be negotiated and genetic resources will be recognized as a common heritage of mankind.

2.3 Genetic resources as Common Heritage of Mankind

In the first section, I mentioned that UPOV plant breeders rights include a research exception or breeder's exception that allows access to genetic resources contained in the protected varieties for breeding purposes. However, this is not enough for feeding the breeding R&D appetite. It is also necessary to facilitate access to the reservoir of genetic resources contained in plants that are in their natural state world wide, but above all in tropical developing countries. This implies that governments should not claim any exclusive right to their genetic resources and should allow international and foreign national research organizations or private

³⁸⁷ Robin Pistorius (1997), *Scientists, Plants and Politics*...p. 57

companies to collect genetic resources on their territory and to conserve them in open-access. As this could become less obvious after decolonization, phyto-genetic resources for food and agriculture are said to be the Common Heritage of Mankind, i.e. in open-access, regardless of national borders.³⁸⁸ Therefore, a general regime of open-access for genetic resources is in process, leaning on two legal concepts: the breeder's exception and the Common Heritage of Mankind. More precisely, a *de jure*³⁸⁹ open-access regime succeeds a *de facto* open-access regime in vigor up till then.

In addition, the legal concept of Common Heritage of Mankind – a new notion that entered into vogue in the late seventies and early eighties – not only provides open access to plants in their natural state but it also constitutes a general legal framework which could integrate the different components of a genetic resources regime; a general open access including all genetic resources, and a management system carrying on their conservation and some R&D.

2.3.1 Common Heritage in International Public Law

2.3.1.1 Common Heritage as a Property Regime

It is generally agreed that the origin of the expression “Common Heritage of Mankind” and its content are to be attributed to the Maltese Ambassador, Arvid Pardo who presented it on 1 November 1967 at the First Commission of the United Nations Assembly discussing the future legal regime of the seabed and its subsoil. At that time, the expression “Common Heritage”, or synonyms, was mainly used in two domains: the management of natural resources (sea, space and genetic resources) and the management of cultural heritage.³⁹⁰ In his well-known course on the notion of Common Heritage of Mankind at The Hague Academy of International Law³⁹¹, - Professor Alexandre Kiss evoked some precedents and parallel concepts, notably *res communis*. It is probably

³⁸⁸ Marie-Angèle Hermitte (2004), “La construction du droit des ressources génétiques...” pp. 26-33

³⁸⁹ Note however, that the legal nature of this property regime is ambiguous as the International Undertaking is not a legally binding instrument.

³⁹⁰ Philippe Khan (1998) “Les patrimoines communs de l'humanité: quelques réflexions”, in Michel Prieur et Claude Lambrechts, *Les Hommes et l'Environnement, quels droits pour le vingt-et-unième siècle?*, Mankind and Environment, What Rights for the Twenty First Century? Etudes en Hommages à Alexandre Kiss, Paris, Editions Frison-Roche, p. 307

³⁹¹ Charles-Alexandre Kiss (1983), “La notion de Patrimoine Commun de l'Humanité” *Recueil de Cours de l'Académie de Droit International de la Haye*, Tome 175, pp. 99-256

about the legal nature of high sea and seabed that the evolution and hesitation are the most illustrative. Very early on it was agreed that the high seas could not be appropriated because of its immensity, and it must consequently escape state sovereignty. However, there has been a long doctrinal debate about the legal statute of high seas between the supporters of the notion of *res nullius* (i.e. things not yet appropriated) and those in favor of the notion of *res communis* (i.e. things open to all by nature). The advocates of *res nullius* mainly put forward objections to the concept of *res communis*, arguing that it implies a common sovereignty, which at the time did not correspond to the state of the law nor the practice. In contrast, the supporters of *Res communis*' argued that *res nullius* implies that anybody can appropriate the thing in question, which is not the case for the high seas. The theory behind *res communis* thus seems more appropriate, as it implies joint-ownership and allows for internationalization and a common regulation. It is further argued that the concept of *res communis*' has been confirmed by the growing regulation of the high seas. Additionally, there is unanimity in considering that outer space is *res communis*,³⁹² thus supporting the contention that the high seas are as well. However, as noted by Alexandre Kiss, the exact meaning of this concept has never been satisfactorily defined.³⁹³ It was only agreed that the high seas and outer space were open to all states.

It seems to me that the doctrinal debate on *res nullius* and *res communis* and the lack of clarity on the notion of *res communis* comes from confusion between the nature of a good and the nature of its property regime. The notion of *res communis* designates a type of good. *Res communis* encapsulates what Professor Carol Rose calls the impossibility argument against private property: the character of some resources makes them incapable of "capture" or any other act of exclusive appropriation.³⁹⁴ To use the economic classification presented in part one, good in *res communis* are non-exclusive goods, which makes them either public goods or common pool resources; whereas *res nullius* designates a property regime, goods in *res nullius* are not goods incapable of ownership, but they are simply things that belong to nobody. Therefore, in my opinion, it is an error to view the notion of *res communis* as a legal regime for the high seas and outer space. The confusion was possible and so long as there are no consequences, things incapable of ownership are *de facto* in open-access. However, the impossibility argument may not be definitive,

³⁹² *Ibidem*, p. 120

³⁹³ This was the main argument of the supporters of the *res nullius* conception

³⁹⁴ Carol Rose (2003), "Romans, Roads, and Romantic Creators..."

technological change can help to overcome technical obstacles or change the costs and benefits of appropriating and make it worthwhile. Indeed, this is what has happened with the part of the sea that has been partly appropriated by States under the legal notion of an Exclusive Economic Zone. In this situation, if it is preferable to keep a good in open access, then it is necessary to set up a *de jure* open-access property regime. In Roman law, things belonging to the public and open to the public by the operation of law were designated as *res publicae*. Thus, *res publicae* does not designate a type of good but rather a property regime where concerned goods are in open-access. Consequently, it is important to note that goods in *res publicae* are not ungoverned; on the contrary open-access requires mechanisms of governance either through informal self-governance or government regulation. Moreover, the notion of *res publicae* is not incompatible with private property and mixed regimes are often needed.³⁹⁵ In modern international law, the concept of the Common Heritage of Mankind constitutes an attempt to embody these ideas.

2.3.1.2 The Content of the Notion of Common Heritage of Mankind

There is no exact and definitive definition of Common Heritage but a list of criteria have been put forward by Avid Pardo and later by Alexandre Kiss and several other authors.³⁹⁶

- 1) Non-appropriation: States may use the space or resources but they may not claim sovereignty over it (open access);
- 2) Peaceful use: only peaceful uses are allowed over the space or resources;
- 3) A system of management: there must be a system of management between all potential users or on their behalf by an international organization;
- 4) Rational and sustainable use: if necessary, use of the common heritage must enable its renewal, and for non-renewable resources, the exploitation must be optimal, taking into account the long term interest of mankind;
- 5) Equitable benefit sharing: the benefits coming from the common heritage use must be equitably shared among the different states.

³⁹⁵ *Ibidem*, p. 100 and ss.

³⁹⁶ S. Bastid (1973) « L'état du droit international public en 1973 », *Journal du Droit International*, p.10 ; J. M. Le Besnaris (1976), « L'Amérique latine et le droit de la mer » *Notes et Etudes Documentaires* n°4316-4317, 27 Septembre, p. 90 ; and Nguyen-Quaoc Dinh-Daillet-Pellet (1980), *Droit International Public*, 2^e éd. Paris, p. 628

In addition, some or all of these criteria are present in a series of conventions concerning Antarctica,³⁹⁷ radio spectrums, outer space³⁹⁸ and celestial bodies, cultural heritage,³⁹⁹ natural resources and the seabed.⁴⁰⁰ Before genetic resources, the notion of Common Heritage of Mankind was explicitly applied to two subject matters: the Moon⁴⁰¹ and above all the seabed, which constitutes the most elaborated legal regime of world common heritage.

2.3.1.3 The Law of the Sea as a Model

The United Nations Convention on the Law of the Sea (UNCLOS) declares that the area –the seabed and ocean floor and subsoil thereof, are beyond the limits of national jurisdiction⁴⁰² – and its resources are the common heritage of mankind. The principles of non-appropriation⁴⁰³ and peaceful uses⁴⁰⁴ are affirmed. No State may claim any sovereignty⁴⁰⁵ on the area and its resources, nor may they behave as they wish but they must behave in accordance with the provisions of the convention.⁴⁰⁶ The area and its resources are vested in mankind through an international organization, called “the authority,” that will assume their management on behalf of mankind. The requirement of rational and sustainable management appears in a litany of instructions notably in terms of environmental protection,⁴⁰⁷ and sustainable use.⁴⁰⁸ Above all, it

³⁹⁷ The Antarctic Treaty signed at Washington, on 1 December 1959, and the Convention on the Conservation of Antarctic Marine Living Resources signed in Canberra in 1980

³⁹⁸ Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, adopted by the General Assembly in its resolution 1962 (XVIII) in 1963, and the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies adopted by the General Assembly in its resolution 2222 (XXI). In 1966

³⁹⁹ Notably, the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage signed in 1972

⁴⁰⁰ United Nations Convention on the Law of the Sea signed in Montego Bay in 1982

⁴⁰¹ The Moon Agreement was considered and elaborated by the Legal Subcommittee from 1972 to 1979. The Agreement was adopted by the General Assembly in 1979 in resolution 34/68. The Agreement provides that the Moon and its natural resources are the common heritage of mankind and that an international regime should be established to govern the exploitation of such resources when such exploitation is about to become feasible.

⁴⁰² UNCLOS, Article 1

⁴⁰³ UNCLOS, Article 137

⁴⁰⁴ UNCLOS, Article 141

⁴⁰⁵ UNCLOS, Article 137

⁴⁰⁶ UNCLOS, Article 138

⁴⁰⁷ UNCLOS, Article 145-146

outlines the mechanisms for benefit-sharing between states taking part in the exploitation of the area and States that are not able to do so. Interestingly, benefit sharing is mainly envisaged in terms of transfer of technology and scientific knowledge to developing countries.⁴⁰⁹ It is also worth noting that scientific research in the area takes an important place in the mind of the Convention Negotiators.⁴¹⁰ In order to assume the sustainable use of this common heritage and equitable benefit sharing, the Convention establishes the Authority⁴¹¹ in charge of the administration of the area,⁴¹² complete with several organs, notably an assembly,⁴¹³ a council,⁴¹⁴ and a secretariat.⁴¹⁵ The Convention also establishes the Enterprise⁴¹⁶ in charge of the exploitation and a tribunal with a Seabed Special Chamber⁴¹⁷ in charge of dispute settlement concerning the seabed.

The objectives of (1), helping developing countries through benefit sharing and transfer of technology, (2) resource conservation, (3) sustainable use, and (4) coordination of scientific research were the same objectives as the negotiators of the International Undertaking on Phytogenetic Resources for Food and Agriculture.⁴¹⁸ Logically, they take the Common Heritage principles – above all the ideas of non-appropriation and rational and sustainable use – as a model. It is important to keep in mind the interlocking of non-appropriation and rational use that has been misunderstood by some critics of the International Undertaking. Open-access does not imply an absence of control. On the contrary, open-access calls for regulation; in a sense property rights and regulation are two alternative forms of control.

2.3.2 The FAO International Undertaking

In 1983, after two years of negotiation, the FAO assembly adopted a non-legally binding resolution called the International Undertaking on

⁴⁰⁸ UNCLOS, Articles 150-154

⁴⁰⁹ UNCLOS, Article 144

⁴¹⁰ UNCLOS, Article 143

⁴¹¹ UNCLOS, Articles 156-158

⁴¹² UNCLOS, Article 157

⁴¹³ UNCLOS, Articles 159 & 160

⁴¹⁴ UNCLOS, Articles 161-165

⁴¹⁵ UNCLOS, Articles 166-169

⁴¹⁶ UNCLOS, Article 170

⁴¹⁷ UNCLOS, Articles 187-189

⁴¹⁸ See Christine Noiville. (1997), *Ressources génétiques et droit, Essai sur les régimes juridiques des ressources génétiques marines*, Paris, Institut Economique de la Mer, Pédone, p. 178

Phylogenetic Resources for Food and Agriculture.⁴¹⁹ The first article affirms its objective and declares that genetic resources are the common heritage of mankind:

*The objective of this Undertaking is to ensure that plant genetic resources of economic and/or social interest, particularly for agriculture, will be explored, preserved, evaluated and made available for plant breeding and scientific purposes. This Undertaking is based on the universally accepted principle that plant genetic resources are a heritage of mankind and consequently should be available without restriction.*⁴²⁰

In terms of access to genetic resources, this declaration has two important implications. First, breeders, scientists or conservation organizations are free to continue collecting genetic resources in biodiversity-rich countries. It was an important element because after the decolonization period, the idea of national sovereignty over natural resources was appealing. Second, this declaration also concerns genetic resources collected and conserved in botanical gardens or gene banks, and it provides that they should be placed in open-access.

As demonstrated by the words used, the status of genetic resources as common heritage is not new. The International Undertaking is declaratory; it does not modify the property regime of genetic resources but recognizes it officially. Indeed, genetic resources have always been implicitly considered to be common heritage. It was notably apparent in several points of the agricultural chain. First, in farmers' communities there are long traditions of collective innovation and seed exchanges due to the perpetual need for new seeds to be adapted to the constantly changing environment. This tradition does not always prevent recognition of individual contribution but possible rewards are more envisaged in terms of reputation rather than in exclusivity.⁴²¹ Besides, this practice was acknowledged in the drafting of the first UPOV Convention that allowed for some resowing and seed exchanges among farmers. The principle of open-access is also in harmony with the practice of the CGIAR. More broadly, as noted by Stephen Brush,⁴²²

⁴¹⁹ Annex to the resolution 8/83 of the 22nd session of the FAO Conference, Rome, 1983. The text is available at the following address: <http://www.fao.org/ag/cgrfa/IU.htm>

⁴²⁰ Emphasis added

⁴²¹ For documentation of such traditions see Stephen Brush (1996) "Is Common Heritage Outmoded?" in Stephen Brush and Doreen Stabisky (eds.) *Valuing Local Knowledge. Indigenous peoples and intellectual property Rights*, Washington, Island Press, p.150

⁴²² *Ibidem*, p. 148

there is a strong convergence between the concept of common heritage and the norms of Science, as is briefly presented in Part One. The norm of Science that most interests us here is the one called "communism" by Merton. It implies a norm of open-access based on the conviction that one cannot monopolize incremental contribution that increases collective knowledge. Once again, this norm of open-access does not imply an absence of obligation; rather it creates a requirement of reciprocity. This close link between the norms of Science and Common Heritage is fostered by the fact that at the time most of the actors involved in the negotiation of the international undertaking were scientists. Finally, the importance of open-access to research material was acknowledged in the text of the UPOV Convention via the breeders' exception.

The interlocking with science and above all breeding activities also appears in the area of application to the open-access regime for collection of genetic resources. This application is defined in terms of (1) subject matter, (2) genetic resources ownership, (3) type of use of genetic resources and (4) is subject to some conditions. First, in terms of subject matter, the International Undertaking does not apply to just any genetic resources but only to the plant genetic resources of species that are of economic and/or social interest for agriculture.⁴²³ Second, Articles 5 draws a distinction between genetic resource owners. Open-access is only required from public collections.⁴²⁴ This limitation has two consequences: private collections are concerned only to the extent that their owners choose to adhere to the system. Improved varieties protected by a breeder's right (UPOV) are not required to be in open-access. However, as explained before, the UPOV Convention leaves the genetic resources included in a protected variety (breeding exception in open-access). Third, a distinction is made between the types of use: open-access to samples is granted for scientific and conservation purposes; other uses are not regulated. Fourth, open-access is submitted to on the condition of reciprocity;⁴²⁵ it is a further illustration of the close link with the norms of science. It is also an incentive for states and private institutions to join, as it seems to indicate that access may be refused to non-adhering institutions. Thus, those distinctions clearly

⁴²³ IU, Article 2

⁴²⁴ Even if the IARCs are not formally signatories of the Undertaking, their collection have always been in open access and in 1994 most of them will sign formal agreements in which they place their collections in the International Network "in trust for the benefit of the international community", and they agree not to claim ownership, or seek intellectual property rights, over the designated germplasm and related information.

⁴²⁵ IU, Article 7

elucidate one of the objectives of the treaty: fostering reciprocal access to genetic resources for agricultural R&D purposes, and the intimate link with science and its norms.

Not only do the Undertaking and the concept of Common Heritage affirm the principle of non-appropriation, but they also integrate the elements of a management system for genetic resource use and conservation for breeding purposes. A Global System on Plant Genetic Resources was set up with the establishment of the FAO Commission on Plant Genetic Resources⁴²⁶ in charge of coordinating reports on the state of the world's plant genetic resources. This Commission was to also put into place a Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture.⁴²⁷ The CGIAR network that provides an important effort for breeding research and conservation is included in the system and it plans to increase the number of centers and further develop the network so as to achieve as complete coverage as necessary, in terms of species and geographical distribution. States together with the CGIAR network are required to collaborate to identify plant genetic resources in danger, and to carry out their conservation and facilitate their exchange.⁴²⁸ The aim is to progressively cover all plant species that are important for agriculture and other sectors of the economy, in the present and for the future.⁴²⁹ In terms of benefit sharing, the IU implicitly affirms that the principal way of sharing benefits lies in the free exchange of material. In addition, it is a goal to establish and strengthen the capabilities of developing countries so as to help them take part in the conservation efforts, but above all to enable them to make full use of plant genetic resources for the benefit of their own agricultural development.⁴³⁰

In this Second Chapter, I have identified a first equilibrium in the evolution of the property regime of genetic resources. One public good –agricultural research – is provided for in part by the private sector, thanks to a *sui generis* intellectual property right and in part by publicly funded research centers. Conservation, a second public good further upstream in the innovation chain, is mainly provided thanks to public

⁴²⁶ It is now named the Commission on Genetic Resources for Food and Agriculture or CGRFA.

⁴²⁷ See the website of the CGRFA <http://www.fao.org/ag/cgrfa/PGR.htm>

⁴²⁸ IU, Articles 4 and 7

⁴²⁹ IU, Article 7

⁴³⁰ IU, Article 6

funding by a network of national and international gene banks. Finally, genetic resources are said to be the common heritage of mankind, i.e. in open access. Observed from the breeders' standpoint, breeder's right (UPOV) and the Common Heritage principle are not contradictory but rather they complement each other. Open-access for genetic resources for conservation and research purposes is the optimal condition for carrying out agricultural research.

However, this equilibrium will be contested for several reasons. First, it will be argued that the equilibrium is unbalanced. If one takes a closer look, it appears that when genetic resources are said to be the common heritage of mankind, they are above all available for breeders (researchers). What lies in open access is the research material, i.e. plants in their natural state (and the genetic resources they contain) as well as genetic resources contained in protected new varieties; whereas exclusive rights protect new varieties developed by breeders. The problem is that while breeders can make use of genetic resources included in a protected variety, farmers only work at the variety level. Exaggerating a little bit, it could be argued that under a *de jure* open access regime, genetic resources are *de facto* the common property of plant breeders, that is to say in open-access among breeders but *de facto* inaccessible for third parties (farmers). In itself, this situation is not problematic but there is an asymmetry among states. Agricultural research capacities are for the most part in industrialized states while most genetic diversity is contained in landraces or wild plant varieties (i.e. unprotectable) located in tropical developing countries. Thinking in terms of varieties rather than in terms of genetic resources, those countries observe that their varieties are in open-access while intellectual property rights protect the northern varieties.

This lack of balance will further increase with the development of biotechnologies, especially in the pharmaceutical sector, which increase the value of genetic resources and call for a reconsideration of the possibility of patenting genetic resources. This, therefore, reduces access to "northern" genetic resources. Moreover, the TRIPs Agreement will reinforce the sense of unbalance. Before the TRIPs Agreement, developing countries were not obliged to offer IPR protection for innovations protected in developed countries. The Paris Convention on patent law only required low standards of protection and allowed for exceptions. In addition, there was no real control on how countries offered effective protection to foreign inventors. This situation will be challenged by the TRIPs Agreement, which will impose high and uniform standards of protection, limit possible exceptions and monitor how countries protect foreign inventors. Finally, biodiversity erosion is

continuing and conservation efforts must be increased. In this context, controlling access to genetic resources and charging for access appears to be a potential means to fund conservation.

In the next chapter, I analyze how this first equilibrium is upset by two changes. Downstream of the innovation chain, patents will be granted on final inventions that reduce open-access. On the upstream side of the innovation chain, traditional farmers and bio-diverse countries will claim control over their genetic resources and require compensation for access, which further reduces open-access. Those two legal changes pave the way for the adoption of the Convention on Biological Diversity that puts an end to open-access and instead relies on exclusive rights to regulate genetic resources.

3. Two Changes and the End of Open Access

In the previous chapter, I mentioned a situation that seemed to be an equilibrium: plant genetic resources in open access, private R&D fostered by an intellectual property right on new varieties, and this all complemented by a publicly funded conservation effort that collected PGR, conserved them and put them at the disposal of breeders or farmers. However, this situation never really been regarded as a balanced regime. As noted by Gregory Rose, *"The IU has been dogged by controversy since its adoption as it deals with the politically explosive issues of PGRs control. Its effectiveness has been hampered by competing interests of the (mostly developing) countries which have a natural abundance of PGR and wish to maintain some control over them, and, on the other hand, the (mostly developed) countries which have made capital investments in refining and wish to exercise control themselves. Each also desires unhindered access to the others' holdings of PGR"*⁴³¹.

In this chapter, I analyze how this equilibrium was contested by a double change. Downstream of the innovation chain, the development of modern biotechnologies modified the costs and benefits of creating IPRs on genetic resources and the possibility of patenting them was reconsidered. Once the patenting of living organisms was admitted, the coexistence of two systems of protections –patent and plant breeders' right- caused some difficulty, which led to a revision of the UPOV Convention. Finally, the TRIPS Agreement extended the choice of patenting living organisms to all WTO members. On the upstream side of the innovation chain, traditional farmers and biodiverse countries claimed control of their genetic resources and demanded compensation for access. Those legal changes, both downstream and upstream of the innovation chain, paved the way for the adoption of the Convention on Biological Diversity, which put an end to open-access and conversely relied on exclusive rights to regulate genetic resources.

⁴³¹ Gregory Rose (1996), "International Regimes for the Conservation and Control of Plant Genetic Resources" in Michael Bowman and Catherine Redgwell (eds), *International Law and the Conservation of Biological Diversity* Kluwer Law International, London, p. 153

3.1 Downstream: the Protection of Final Inventions

I previously argued that in the middle of the twentieth century the early developments in genetics and the breeding sector growing autonomy from agriculture led to a demand for economic incentives under the form of plant breeders' rights. In the first part of this dissertation, I mentioned the theory of property rights developed by Demsetz and others,⁴³² which predicts that the creation and the enforcement of property rights is primarily a function of changes in value. When the value of a good rises, potential owners will attempt to convince governments or courts to change property laws to allow for the capture of the new value. Exogenous change as technological changes that increase the value of a good can create sufficient incentives for the development of property rights. In the 1980s and 1990s, the advent of modern biotechnology and related changes in the innovation process increased the potential benefits of increased appropriation of genetic resources and led to a reconsideration of the possibility of patenting living organisms. In addition, the technical or intellectual obstacles to patentability were progressively overcome. Then, in reaction to genetic resources patenting, plant breeders asked for a revision of the UPOV Convention. Finally, the TRIPS agreement extended intellectual property to all WTO members.

3.1.1 Technological Changes

The emergence of new biotechnologies significantly improves our ability to utilize plant genetic resources. In particular, recombinant DNA techniques, in combination with a series of other technologies such as tissue culture, cell fusion, fermentation, and enzyme technology move the focus of the biological sciences to cellular and molecular structures, and are increasingly overcoming the natural barriers that prevent the exchange of genetic materials between different species. It is in principle possible to isolate any DNA fragment from any organism, and incorporate it into any other organism. **This enhances the potential economic value of genetic resources** not only in the agricultural sector but in many other sectors and specifically in the pharmaceutical sector. The increasing value of genetic resources results in pressure to bring

⁴³² Harold Demsetz (1967) in "Towards a Theory of Property Rights" 57 AMERICAN ECONOMIC REVIEW 347; Thrainn Eggertsson (1990) *Economic Behavior and Institutions*, Cambridge University Press; Douglas C. North (1990), *Institutions, Institutional Change and Economic Performance*, Cambridge: Cambridge University Press; Yoram Barzel (1997) *The Economic Analysis of Property Rights*, Cambridge: Cambridge University Press

genetic resources, such as DNA segments, genes, and cell lines, under the protection of the industrial patent system.

This move is further increased by the arrival of **new economic actors**. The commercialization of biotechnology offered new opportunities to industries from the chemical sector whose development was threatened by the difficulty to identify new useful, safe and environment friendly molecules. Moreover, biotechnologies foster synergies between their agricultural and non-agricultural (pharmaceutical, energy, chemicals) applications and increased the diversification of large chemical and pharmaceutical companies. So, in the agricultural sector, one observed several large chemical companies turning to agricultural biotechnologies and purchasing seeds companies for their expertise in seed production and plant breeding as well as for their marketing outlets.⁴³³ In the agricultural sector where the public and private R&D sectors had long coexisted, one observed **an increasing involvement of the private sector** in agriculture accompanied by **stagnancy in public funded R&D**. In the USA, for instance, the private sector spending on plant breeding increased between the 1960s and the 1990s at an average annual rate of growth of seven percent and was multiplied by more than ten. In contrast, public sector expenditures rose more slowly until 1980, after which it stagnated and even declined.⁴³⁴

In conclusion, the new developments of biotechnologies, the effect of budgetary constraints on public R&D and the interest of the private sector increased the potential benefits of intellectual property rights. In addition, new biotechnological products lent themselves to more absolute forms of proprietary protection, especially industrial patenting. Breeders using direct gene transfer (transgenesis) and similar techniques have an interest in legally protecting genes and gene complexes themselves, rather than the finished crop varieties. Finally, biotechnologies foster interest in genetic resources not only in agriculture but also in a large range of sectors, particularly the pharmaceutical industry. Therefore, regulation of genetic resources is no

⁴³³ FAO Commission on Plant Genetic Resources (1989), "Implications of New Biotechnologies for the International Undertaking" CPGR/89/9 and Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques..." p. 36

⁴³⁴ P.W Heisey,., C.S. Srinivasan and C. Thirtle (2001), "Public Sector Plant Breeding in a Privatizing World" AGRICULTURAL INFORMATION BULLETIN, No. 772 Economic Research Service, US Department of Agriculture, Washington D.C., and Susan Bragdon (ed.) (2004), "International Law of Relevance to Plant Genetic Resources: A Practical Review for Scientists and Others Professionals Working With Plant Genetic Resources", ISSUES IN GENETIC RESOURCES No.10 pp. 111-115

longer the monopoly of the agricultural R&D community; it has become a multi-sector issue where the pharmaceutical sector plays a leading role. As a consequence, there is a strong call for the reconsideration of the issue of patenting genetic resources and more broadly living organisms. For this purpose, technical and intellectual obstacles to patentability are progressively overcome.

3.1.2 Legal Changes

3.1.2.1 Patenting of Genetic Resources

The Disclosure Requirement and the Budapest Treaty

As mentioned earlier, one of the main obstacles to the patentability of plant varieties, and more broadly living material, was that they do not meet the statutory requirement for description.⁴³⁵ Indeed, a fundamental requirement of patent law is that the details of the invention must be fully disclosed to the public. For the disclosure to be adequate, an invention must be described with sufficient precision to permit a person skilled in the art to repeat the effect of the invention. Description is normally achieved by a written description, sometimes completed by some drawings. However, inventions involving the use of new microorganisms feature problems of disclosure in that their repeatability often cannot be achieved by means of only a written description. For instance, in the case of an invention consisting of a microorganism isolated from the soil or the sea and improved by mutations and selection, it would be impossible to describe the strain and the selection sufficiently for another person to obtain the same invention from the soil or the sea.

In the 1970s, this growing importance of inventions including microorganisms led to some industrialized countries requiring or recommending that the written disclosure of the invention be complemented by the deposit of the microorganism in a recognized culture collection. The microorganism then became available to the public at the appropriate point in the patenting procedure. Actually, the deposit requirement was less an additional requirement than an alternative to the description requirement and it helped overcome one of the main obstacles to the patenting of living organisms. The adoption of the Budapest Treaty on International Recognition of the Deposit of

⁴³⁵ In Europe, Article 83 of the European Patent Convention, in the United-States, 35 U.S.C. § 112

Microorganisms for the Purpose of Patent Procedure in 1977 and its entry into force in 1980 generalized and organized the deposit practice.

Thus, at the end of the 1970s, there was a legal framework that allowed for the patentability of microbiological inventions and their products but it had not been conceived to patent microorganisms as such.⁴³⁶ In fact, there was another obstacle to overcome: discoveries or products of nature were not deemed patentable. However, the courts and statutory change later helped to overcome this second obstacle.

Disregarding Discovery and Product of Nature Objections

The first step came in 1980 from the Supreme Court of the United States with its *Diamond v. Chakrabaty* decision. Before that decision, it was generally agreed that discoveries and products of nature were not patentable. In *Funk Bros. Seed Co. v Kalo Inoculant Co.* the Court repeated the general principle that products of nature were not patentable.⁴³⁷ It held that *natural products like the heat of the sun, electricity, or the qualities of metals, are part of the storehouse of knowledge of all men. They are the manifestations of laws of nature, free to all men and reserved exclusively to none. He who discovers hitherto unknown phenomenon of nature has no claim to a monopoly of it that is recognizable under the law. If there is to be an invention from such a discovery, it must come from the application of the law of nature to a new and useful end.*⁴³⁸

In 1980, *In Chakrabaty v Diamond*, the Supreme Court admitted the patentability of genetically modified microorganisms. In 1972 Mr. Chakrabaty filed a patent for a human-made, genetically engineered bacterium capable of breaking down multiple components of crude oil. Because of this property, which was not possessed by any naturally occurring material, Chakrabaty's invention could have had significant value for the treatment of oil spills. Chakrabaty's claims included a claim to the bacteria itself. The patent examiner disregarded the fact that no naturally occurring material had the same property and rejected that

⁴³⁶ Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques...", p. 36

⁴³⁷ However to be precise, it must be mentioned that the principle that a discovery is not to be patented had first been challenged in 1939 in *Dennis v. Piñer*. The patentee claimed that he had discovered an insecticide in an extract from the root of a cube plant. The Supreme Court held that the subject matter was patentable. However the patent was finally not granted because it appeared that the patentee was not the first to discover the insecticide use of cube plants roots. See *Dennis v. Piñer*, 106 F.2d 142, 145 (7th Cir. 1939)

⁴³⁸ *Funk Bros. Seed Co. v Kalo Inoculant Co.*, 333 US 127 (1948)

claim on two grounds: (1) that micro-organisms are products of nature and (2) that as living organisms they are not patentable subject matter. Upon appeal, it was affirmed the examiner on the second ground. Relying on the legislative history of the 1930 Plant Patent Act and the 1970 Plant Variety Patent Act, the Board argued that the 35 U.S.C. § 101 statutory terms “manufactured objects” and “composition of matter” did not include living material and that a legislative act was required to include them as patentable subject-matter. The Court of Customs reversed on the authority of its previous decision *in re Bergy*⁴³⁹ in which it held that the fact that microorganisms are alive is without legal significance to patent law. The Supreme Court affirmed the Court of Customs decision agreeing that the relevant distinction is not between living and inanimate things, but between products of nature, whether living or not, and **human made inventions**. In so doing, the court provided a more restrictive interpretation of the product of nature doctrine than that of the patent office and gave the largest interpretation ever of patentable subject matter, holding that it included *anything under the sun made by man*.⁴⁴⁰

After this first step, the patentability of living organisms quickly extended both geographically and in terms of subject matter.

Fearing they would loose competitiveness, industrialized countries quickly followed the American direction. In Europe, the European Patent Office and the courts took into account article 53 of the European Patent Convention that provided some exceptions to patentability. In particular paragraph B stated that European patents shall not be granted in respect of *(b) plant or animal varieties or essentially biological processes for the production of plants or animals; this provision does not apply to microbiological processes or the products thereof*. On 11 December 1981, one year after the *Chakrabaty v Diamond* decision, the European Patent Office (EPO) provided an interpretation of Article 53.b affirming that microbiological processes – that are patentable under the convention – included the fabrication process of new micro-organisms, for instance by genetic engineering, and it made clear that the product obtained by those processes, i.e. the micro-organism itself, is patentable as a product. So, by an administrative decision of the EPO, Europe followed the United States in the patentability of living forms.⁴⁴¹ There were some discordant

⁴³⁹ *In Re Bergy*, 563 F.2d 1031 (1977)

⁴⁴⁰ Yet the Court qualifies its broad statement with the declaration that *law of nature, physical phenomena and abstract ideas* are not patentable.

⁴⁴¹ For more details, see Marie-Angèle Hermitte (2004), “La construction du droit des ressources génétiques...” pp.39-40.

voices, like the Austrian patent office, which in 1985 decided against the patentability of micro-organisms. However, in the face of opposition, the Austrian parliament modified the legislation and confirmed the patentability of living organisms.

Then, both in the United States and in Europe, **patentability was quickly extended to all forms of life**. First, cell and tissues were assimilated to microorganisms and were available to be patented. Logically, genes that are inserted into cells or microorganisms also became patentable. Then, the next issue was the patentability of modified plants. In the United States, the issue was whether the existence of specific legislation, such as the Plant Patent Act and the Plant Variety Patent Act, prevented the patentability of plants. In *Ex parte Hibberd*⁴⁴² the Patent Office Board of Appeal concluded that plants can fall under statutory scope and be granted a patent. In 2001, the Supreme Court confirmed the legality of fifteen years of plant patenting in *J.E.M. AG. Supply Inc. v. Pioneer Hi-Bred Int'l Inc.*⁴⁴³

In Europe, the patentability of plants is ruled by article 53b of the European Patent Convention that forbids the patenting of plant and animal varieties. However, some commentators⁴⁴⁴ argued that UPOV-type protection provides insufficient incentives to foster investment in plant biotechnology and pled in favor of plant patenting. The EPO partly followed those comments by adopting a narrow interpretation of article 53b. In *Transgenic Plant/Novartis II*,⁴⁴⁵ the Enlarged Board of Appeals of the EPO permitted the issue of patents on genetically engineered plants provided that the claims were not directed to a specific variety or varieties. The Board argued that a claim to *a plant defined by single recombinant DNA sequences* was patentable because the claim was *defined by a part of its genotype* and not by the *taxonomic category within the traditional classification of the plant kingdom to which the plants belong*.⁴⁴⁶ But a claim directed to a specific variety was not allowed even where the new variety had been created by genetic modification resulting from a biotechnological process.⁴⁴⁷ The Board of Appeal interpreted article 53b

⁴⁴² *Ex parte Hibberd*, 227 USPQ 443 Bd. Pat. App. 1985

⁴⁴³ *J.E.M. AG. Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc* 534 U.S. 124 (2001)

⁴⁴⁴ See Joseph Strauss (1989), "AIPPI and the Protection of Inventions in Plants –Past Developments, Future Perspectives", 20 INT'L REV. IND. PROP & COPYRIGHT L. 600, or Joseph Strauss (1986), "Patent Protection for New Varieties of Plants: Should 'Double Patenting' Be Prohibited?" 17 INT'L REV. IND. PROP & COPYRIGHT L. 95

⁴⁴⁵ *Transgenic Plant/Novartis II*, G 001/18 (EPO Enlarged Board of Appeals, December 20, 1999)

⁴⁴⁶ *Ibidem*, at 19

⁴⁴⁷ *Ibidem*, at 36

as serving the purpose of excluding from patentability subject-matter which is eligible for protection under UPOV. However, this interpretation does not prevent double protection because a breeder's right could cover a particular variety that could also fall within a broader patent defined by its genotype.

An additional step occurred when the concept of invention was interpreted to include not only human made inventions but also **substances isolated** from a naturally occurring material;⁴⁴⁸ this was the end of the product of nature doctrine. The distinction is important because most microorganisms and genes are not manipulated and are used for their natural properties. Moreover, this means that genetic resources collected in developing countries could be patented after mere isolation without any further modification.

Consequences

Patenting of genetic resources has important consequences in terms of access. While the UPOV plant breeders' rights protects plant varieties and leaves genetic resources in open-access, patents grant exclusive rights on genetic resources themselves. Moreover, in contrast with plant breeders' right, patent legislation includes no or limited research exceptions. In addition, plant patents do not permit farmer's privilege and seeds exchange among farmers.⁴⁴⁹ Finally, the coexistence of two systems of protections –patent and plant breeders' rights- causes some difficulty and has led to a revision of the UPOV Convention.

3.1.2.2 The Revision of the UPOV Convention

The extension of patent to plants and the recognition of legal ownership of single genes, gene complexes, genetic characteristics and specific techniques used to produce new crop varieties, is a direct challenge for the traditional breeding sector and its protection under the UPOV plant breeders' right. In opposition to plant breeders' rights, industrial patents prevent plant breeders from freely using each other's varieties because parts of the genetic resources contained in these varieties have been recognized as someone else's exclusive property. This difference between UPOV plant breeders' rights and patent law creates an

⁴⁴⁸ See article 3.2 of the Directive 98/44/EC of the European Parliament and the Council on the Legal Protection of the Biological Inventions.

⁴⁴⁹ Note however that in the EU, the Directive will introduce a limited farmers privilege in patent law (*Cf. infra*)

asymmetry between plant breeders using classical breeding methods and modern biotechnological inventors. Indeed from the classical plant breeder viewpoint, there is danger that the more commercially valuable patented genes and gene complexes will accumulate in new varieties. This implies that breeders will have to obtain the consent of several patents holders and pay increasing royalties. Conversely, from the modern biotechnological sector perspective, there is a need for stable varieties in which interesting genes can be included. To access such varieties, biotech companies can either buy traditional seed companies or simply take advantage of their own varieties. Indeed, under the terms of 1978 UPOV Convention, a breeder cannot prevent a biotech company from using one of its varieties, introducing some genes within it and be granted protection. In other words, the 1978 UPOV Convention allowed protected varieties to be open-access research tools for biotech companies whereas classical breeders lost access to any variety containing a patented gene.⁴⁵⁰

This unbalanced situation led in 1991 to the adoption of a new version of the UPOV Convention. While conserving the principles of an exclusive right to plant varieties and the breeder's exception, this new version introduces the notion of "**essentially derived variety.**" Henceforth, the breeder's exclusive right extends to *varieties which are essentially derived from the protected variety*, that is to say varieties that meet the UPOV protection requirement of distinctiveness but which have conserved the main biological and commercial characteristics of the initial variety.⁴⁵¹ This new element can be seen as an extension of protection or as an exception to the breeder's exception. It introduces a sort of inventiveness threshold, not as a protection requirement but rather as a condition to have access to the protected variety. As a consequence, a biotechnological inventor wanting to use a protected variety and to introduce a new gene within must obtain the permission of the breeders and pay royalties. This way a balance is reintroduced

⁴⁵⁰ Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques...", p. 47

⁴⁵¹ Article 15 considers a variety as essentially derived from another variety when

- 1) it is predominantly derived from the initial variety, or from a variety that is itself predominantly derived from the initial variety, while retaining the expression of the essential characteristics that result from the genotype or combination of genotypes of the initial variety,
- 2) it is clearly distinguishable from the initial variety and it is clearly distinguishable from the initial variety and
- 3) except for the differences which result from the act of derivation, it conforms to the initial variety in the expression of the essential characteristics that result from the genotype or combination of genotypes of the initial variety.

between classical breeders resorting to PBRs and biotech companies using patent.⁴⁵² However, the result is a renewed attack against open access of genetic resources.

The re-working of the 1991 UPOV Convention was also an opportunity to introduce two additional changes that further reduced the open access of genetic resources. First, **the prohibition of double protection was removed**. In its 1978 version, the UPOV Convention required member states to protect new plant varieties either by plant breeders' right or by patent but stipulated that *states admitting protection under both these forms may provide only one of them for one and the same botanical genus or species*⁴⁵³. On request of the United States, which provided both types of protection, this restriction was suppressed in the 1991 UPOV Convention and member states were free to grant both protections for the same element.⁴⁵⁴

Second, **the so-called farmer's privilege** that allows them to use former harvests as seed sources for subsequent seasons (farmer-saved seeds) **became more regulated**. Actually, the farmer's privilege was explicitly mentioned for the first time. Thus far, the farmer's practice of resowing was not mentioned in the UPOV Convention but was tolerated as an old practice. However, the meaning of the practice has changed, as farmers no longer reuse their own inventions but instead use the research results of a plant breeding companies. As long as the resowing practice remained limited, breeders tolerated it. Then, when diminishing prices of cereals led farmers to increase resowing,⁴⁵⁵ the cost and benefit of monitoring farmer's resowing activities was modified and they asked for compensation. The pressure towards regulating farmer's resowing practices was further increased by the competition of patent laws that provided a stronger degree of monopolization and legally excluded the

⁴⁵² In addition in the European Union, article 12 of the Directive 98/44/EC of the European Parliament and the Council on the Legal Protection of Biological Inventions (OJ L 213/13 30.07.98) requires member states to introduce non-exclusive cross-compulsory licenses where a breeder cannot acquire or exploit a plant variety right without infringing a prior patent or where the holder of a patent concerning a biotechnological invention cannot exploit it without infringing a prior plant variety right.

⁴⁵³ Article 2, International Convention for the Protection of new Varieties of Plants of December 2, 1961, as revised at Geneva on November 10, 1972, and October 23, 1978

⁴⁵⁴ According to a 1999 survey by the World Seed Federation, there are only a few countries (namely USA, Australia and Japan) where protection through utility patents is also used and mainly implemented in the US.

⁴⁵⁵ Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques...", p. 47

possibility of farmers using their own seeds. Consequently, article 15.2 of the 1991 UPOV regulates farmer's resowing under the form of an optional and limited exception to the plant breeders' right. Member states may authorize farmers to use their harvest as a seed source but farmers can only use the harvest that they have obtained on their own holdings and only for their own use. Therefore, seed exchanges among farmers or seed sales by farmers are prohibited. In addition, resowing must remain *within reasonable limits and [is] subject to the safeguarding of the legitimate interests of the breeder*.

Farm-Saved Seed of Small Grain Cereals in the EU

Country	% of total seed demand
Germany	50
France	50
Italy	70
Netherlands	20-25
Denmark	5
Ireland	20
UK	30
Greece	90
Spain	90
Belgium	35

Source: Rabobank (1994)⁴⁵⁶

As the farmer's privilege has become optional, the situation varies according to the choice made by UPOV member states. In the European Union, the matter of plant breeders' right is ruled by the Council Regulation No 2100/94 of 27 July 1994 on Community Plant Varieties Rights⁴⁵⁷ (hereafter the basic regulation), which includes the farmer's privilege. The basic regulation authorizes farmers to use their harvest as seed sources under limited conditions as set forth in the UPOV Convention: they can only use the harvest that they have obtained on their own holdings and only for their own use. Regarding the 1991 UPOV convention requirement to safeguard the *legitimate interests of the breeder*, the basic regulation draws a distinction between small farmers and other farmers. The former category may freely resow their harvest while the latter group is required to pay an equitable remuneration to the holder of the plant breeders' right (PBRs).

⁴⁵⁶ Rabobank (1994), *The World Seed Market: Developments and Strategy*, Agricultural Economic Institute (LEI-DLO)/Rabobank/Ministry of Agriculture, Nature Management and Fisheries, Netherlands

⁴⁵⁷ Council Regulation (EC) No 2100/94 of 27 July 1994 on Community plant variety rights (OJ L 227 of 01.09.94 p. 1)

In addition, the basic regulation and its implementing rules⁴⁵⁸ provide an interesting system, inspired by the copyright system, to deal with the important **transaction costs** that this system is likely to cause. This system contains elements that can be analyzed in terms of liability rules as well as collective rights organization. Liability rules help reduce bargaining costs by suppressing the need to obtain the consent of the entitlement holder and provide a mechanism of collective valuation. While collective rights organizations can help reducing search costs, bargaining costs, and monitoring or enforcement costs. **Bargaining costs** designate the costs of reaching an agreement. In this case, they can be high for a series of reasons. If there is contestation among farmers of the legitimacy of the restriction of the farmer's privilege, it does not favor the reaching of agreement. Similarly, plant breeders accept this system as a compromise but would prefer farmers to buy new seeds every year. In addition, the cost of negotiating royalties with each farmer might be high in comparison with the small amount of money at stake. Consequently, one can see in the implementing rules an attempt to overcome this difficulty. The choice of a statutory license (as there exist many in copyright laws) or a **liability rule**, in Calabresi & Melamed's and Reichman's terminology, suppresses the need to obtain the consent of the breeders who might be reluctant to authorize cheap resowing and rather prefer promoting the sale of new seeds. Regarding the collective valuation of the remuneration to be paid, the implementing rules support the conclusion of standard agreements on the level of the remuneration to be paid by means of negotiation between breeders' and farmer's organizations. Then, the implementing rules provide that agreements between breeders' and farmer's organizations shall be used as guidelines for the determination of the remuneration to be paid in the area of and for the species concerned.⁴⁵⁹ Finally, to further decrease bargaining costs, the implementing rules provide a default rule for the determination of the level of remuneration.⁴⁶⁰ So, if the parties cannot reach an agreement or if they do not want to incur the costs of negotiating a customized contract, they can rely on the default rule.

⁴⁵⁸ Commission Regulation (EC) No 1768/95 of 24 July 1995 implementing rules on the agricultural exemption provided for in Article 14 (3) of the Council Regulation (EC) No 2100/94 of 27 July 1994 on Community Plant Variety Rights, (OJ L 172, 25/07/1995 pp. 0014-0021) as amended by 398R2605 (OJ L 328 04.12.98 p. 6)

⁴⁵⁹ Article 5 par. 4 of the Commission Regulation (EC) No 1768/95 of 24 July 1995 as amended in 1998

⁴⁶⁰ In that case, the remuneration shall be 50% of the amounts charged for the licensed production of propagating material (article 5 par. 5)

Regarding others categories of transaction costs, **search costs** refer to the costs of locating an exchange partner; that is to say locating a person who wants to buy what you are selling or sell what you want to buy; **monitoring and enforcement costs** include the cost of monitoring the behavior of the parties and the cost of sanctioning violations of the agreement. The cost of identifying and above all monitoring farmers' resowing has long been one the main reasons for plant breeders to tolerate it. As European agriculture is increasingly regulated, it becomes easier to obtain information to monitor farmers' behavior. The implementing rules provide some help for reducing monitoring costs by encouraging rights holders to negotiate information requirements with farmers and processors. Processors here play a fundamental role because farmers most often need their help to process a part of their harvest into seeds; consequently they can provide rights holder with useful information.⁴⁶¹ In addition, the implementing rules provide default rules in case rights holders, processors and farmers could not reach an agreement or would not incur the cost of negotiating customized information obligation.⁴⁶² Finally, the implementing rules call for the negotiations of arrangements with organizations of farmers and processors to ensure assistance in the monitoring of the use of the farmer's privilege.

To take advantage of this legislation, plant breeders have gathered into associations that act as copyright **collective rights organizations**.⁴⁶³ In some European countries, they negotiate standard agreements with farmers associations on the amount of compensation. Acting on behalf of a large number of plant breeders, they monitor farmers resowing, they collect the fee, and when necessary they can also sue farmers refusing to pay or to provide information on their activities. In so doing, they reduce monitoring and enforcement costs to a reasonable level. For example, the *Saatgut-Treuhandverwaltungsgesellschaft mbH (STV)*, a German breeders association, acts on behalf of more that 60 plant breeders detaining rights on more that 500 plant varieties. It sends information

⁴⁶¹ Articles 8 and 9 of the Commission Regulation (EC) No 1768/95 of 24 July 1995

⁴⁶² *Ibidem*

⁴⁶³ Article 3 of the Commission Regulation (EC) No 1768/95 of 24 July 1995 explicitly provides that plant breeders associations may act on behalf of their members. Questioned on what conditions an breeders organization could rule In a recent case the European Court of Justice précised the conditions under which a breeders' organization can act on behalf of their member. ECCJ 11 March 2004 C-182/01 *Saatgut-Treuhandverwaltungsgesellschaft mbH v. Werner Jager*.

requests to most German farmers and has sued several of them who refused to either provide information⁴⁶⁴ or pay.

Finally, it should be mentioned that in the European Union the Farmers privilege is no longer a specialty of the UPOV system. The Directive 98/44/EC on the Legal Protection of Biological Inventions obliges the Member States of the European Community to introduce a similar farmer's privilege into their patent laws.⁴⁶⁵

3.1.2.3 The TRIPs Agreement: Geographical Extension of IPRs

After the extension of patent and plant breeders' rights protections to genetic resources, the next step in the appropriation of genetic resources lies in the geographical extension of intellectual property laws, especially in the protection within developing countries for inventions made in developed countries. Until 1994, every state was free to adopt the level of protection it wanted. Actually, many countries, especially less developed and developing countries, offered a low level of protection and little help in the enforcement of property rights obtained in another country. In addition, those countries often excluded several subject matters from protection, most notably medicines and living organisms. However since the late 1970s, the industrialized countries, stroked by the slowdown of their economies and the competition of newly industrialized countries, have realized that their main comparative advantage lies in their technological advances and they want to reinforce it by generalizing and strengthening intellectual property protection. After some unsuccessful negotiations in the framework of the World Intellectual Property Organization (W.I.P.O.), the discussions are turned to the G.A.T.T. where the generalization and strengthening of intellectual property law can be negotiated against other trade issues like providing access for developing countries products into the markets of industrialized countries.⁴⁶⁶ As a consequence, the 1994 Marrakech Agreements, which found the World Trade Organization (W.T.O) and

⁴⁶⁴ In a recent decision, the European Court of Justice construed the farmer's information obligations in restrictive terms. ECCJ 10 April 2003 C-305-00 *Shulin v Saatgut-Treuhandverwaltungsgesellschaft mbH*

⁴⁶⁵ Article 11 of the Directive 98/44/EC of the European Parliament and the Council on the Legal Protection of Biological Inventions (OJ L 213/13 30.07.98)

⁴⁶⁶ For a brief historical account of the TRIPs negotiation see Nicolas Brahy and Selim Louafi (2004), "La Convention sur la Diversité Biologique..."pp. 18-19. For a detailed account see Susan K Sell (1998), *Power and Ideas, North-South Politics of Intellectual Property and Antitrust*, State University of New York, New York.

concluded the G.A.T.T round of negotiations (Uruguay Round), include an Agreement on the Trade Related Aspects of Intellectual Property Rights (TRIPs).⁴⁶⁷ The TRIPs Agreement first requires W.T.O. member states to join the main existing international conventions on intellectual property, and then it raises the minimum standards of protection. More precisely, article 27§1 requires member states to provide patents for any invention, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step and are capable of industrial application. Consequently, the freedom of W.T.O. member states to deny patent protection to some subject matters is strongly restricted. Concerning living material, under the terms of article 27§3(b), inspired by the European Patent Convention, W.T.O. member states may only exclude from patent protection plants, animals and essentially biological processes for their production but they may not exclude micro-organisms and microbiological processes. In addition, they must provide protection for plant varieties, either by patents or by an effective *sui generis* system or a combination of both.

As a consequence of the TRIPs Agreement, developing countries must now protect plant varieties and biotechnological innovations. Not only do they have to protect their own inventions but above all they have to protect within their territory inventions made abroad.

3.2 Upstream: Protection of Inputs to Innovation

The abandonment of the Common Heritage (open access) doctrine may also be explained in regards of technological change and the two complementary bodies of theory on the justification, creation and evolution of property rights previously described.

3.2.1 Technological Change: In Situ Conservation and Compensation for the Inputs to Innovation

First, biotechnological developments give the impression that raw plant genetic resources are extremely valuable. Some voices even use the expression *Green Gold* to describe raw genetic resources. As suggested by Demsetz and others, the prospect of appropriating a part of the rent provided by biotechnological inventions incites biodiversity rich

⁴⁶⁷ The TRIPs Agreement is annex 1C of the Marrakech Agreement Establishing the World Trade Organization, signed in Marrakech, Morocco on 15 April 1994.

countries to reject the Common Heritage doctrine and to claim compensation for their resources. In addition, there had already been a growing feeling among these countries that there was an asymmetry between the North and South and they had the conviction that the regime created by the UPOV Convention and the International Undertaking was unbalanced. This conviction was reinforced by the patenting of genes and plants, which further reduces the open access to genetic resource included in modern varieties.

Second, the theory of property rights developed by Coase predicts that problems of externalities and public goods can be solved by the creation of property rights. I have already explained that conservation of genetic resources is a public good. Thus far, the option chosen to ensure conservation has consisted in publicly funded programs *ex situ* conservation funded where the conserved genetic resources are in open-access. However, it progressively appears that *ex situ* conservation is not sufficient and must be completed by *in situ* conservation. This observation leads first to a reconsideration of the role of traditional farmers and developing countries in the conservation of genetic resources. Then, it requires choosing the best way to fund *in situ* conservation, i.e. a public good, either by public funding or property rights.

Ex situ and *in situ* conservation are two strategies to reach complementary but not identical objectives. As I previously mentioned biodiversity operates as an input into agricultural and pharmaceutical R&D both as a stock and as a flow. *Ex situ* conservation is static in nature: it attempts to freeze the current stock of germplasm for later use. From the set of existing varieties, a set is selected and conserved in a gene bank. In that case, their information content is frozen at the time of collection. The information contained in non-conserved genetic resources is likely to disappear with the ongoing biodiversity erosion. Similarly, future information flows from the conserved varieties is lost because in gene banks stop adapting to the constant evolution of their natural environment. In brief, *ex situ* conservation consists of an attempt to make the optimal use of existing stocks of information contained within the existing stock of genetic resources.⁴⁶⁸

⁴⁶⁸ Timothy Swanson and Timo Goeschl (1999), "Optimal Genetic Resource conservation: *in situ* and *ex situ*", in Stephen Brush (ed.), *Genes in the Field. On Farm Conservation of Crop Diversity*, Lewis Publisher (Boca Raton, USA), IDRC (Ottawa, Canada) and IPGRI (Rome, Italy), p. 182

Conversely, the stake of *in situ* conservation is precisely to focus on the “reception” of information flows. *In situ* conservation is dynamic in nature; it allows varieties currently in use to evolve. Therefore, *in situ* conservation requires very different types of actions. It does not consist in the creation or collection of genetic resources but rather constitutes an attempt to tackle directly the cause of biodiversity erosion. As I explained in Chapter One, two important causes of biodiversity erosion are first the conversion of the naturally existing areas to other land uses, which are more highly valued by humans and second, a phenomenon of specialization in a limited number of species and varieties within agriculture (Cf. Part II, chapter 1). The FAO and the agricultural R&D community will first focus on specialization and then reconsider the contribution of traditional farmers to *in situ* conservation. Then, not only the FAO but also the environmental community will pay more attention to the conversion process and the role of biodiverse countries.

3.2.1.1 Specialization and the Role of Farmers

One aspect of *in situ* conservation lies in the continuing cultivation of a large diversity of crops by farmers together with their practice of observation and selection.⁴⁶⁹ Professors Swanson and Goeschl regard the flow of information or the innovation chain in the agricultural R&D as a three stages process.⁴⁷⁰ Stage I designates the information produced by an ecosystem and natural selection. Only varieties that are able to survive threats, like pests and pathogen, survive. As the threats are constantly changing, the environment produces a continuous flow of new information on the characteristics that are fit under the current environment. Stage II designates the contributions of traditional farmers. Traditional farmers have survived by observing the naturally generated flow of information and by selecting and using interesting traits and characteristics. In this way, traditional plant varieties constitute a stock of information on naturally generated resistance strategies that have been successful in changing the environment over time. Farmers are the receptors of this information. Stage III is the modern plant-breeding sector that uses nature and farmers as information providers. The plant breeding industry collects landraces and their informational content and tries to recombine and concentrate interesting traits into new varieties.

In situ conservation implies a group of individuals who continue to dedicate some amount of land to the cultivation of a large diversity of varieties so as to maintain the flow of information. Because of regional

⁴⁶⁹ *Ibidem*, p. 167

⁴⁷⁰ *Ibidem*, p. 171

diversity, access to large market was not sufficient to induce specialization; In addition, because using a large diversity of crops and technologies has long been used as an insurance mechanism against varieties yield variability, the amount of crop diversity maintained by farmers in developing countries has long been sufficient to maintain a substantial base of resources for agricultural R&D. This base, however, is threatened⁴⁷¹ by a process of specialization.

Modern agriculture involves very different technology from traditional farming. It relies on a limited number of homogenous and high yielding varieties and their related inputs, as well as chemicals and mechanization. As the share of modern agriculture increases, homogeneity replaces traditional diversity. The spread of Green Revolution hybrids and the associated techniques have resulted in the cultivation of fewer varieties of crops. Some crops have seen upwards of a ninety percent reduction rate in crop varieties.⁴⁷² In addition, today's economy provides farmers with alternative insurance mechanisms on the financial and labor markets.⁴⁷³ Consequently, farmers are increasingly reluctant to provide *in situ* conservation service, and there is a need to give them economic reasons to continue.

As a consequence, it is progressively acknowledged that developing countries biodiversity does not only consist of wild varieties provided by nature but instead a large part has been conserved and improved by generations of local farmers. It thus appears that farmers can play a key role in the conservation of genetic resources, not only for their own benefit but also for the international community. This "on farm conservation" effort could be fostered by some compensation. The feeling that farmers' varieties embody some innovation that should not be available for free, especially when the development of biotechnology increases the value of genetic resources and sharpens the conflict for their control, sharpens this trend. The idea that traditional farmers deserve compensation for their inputs was first recognized in 1989 with

⁴⁷¹ *Ibidem*, p. 165. See also FAO (1996) *Report on the State of Plant Genetic Resources for Food and Agriculture* prepared for the Technical Conference on Plant Genetic Resources; Leipzig, Germany; 17-23 June 1996. It notes that there should be a halt on the extinction of farmers' varieties because the replacement of farmers' varieties by modern varieties of crops is an important cause of genetic erosion.

⁴⁷² http://en.wikipedia.org/wiki/Green_revolution

⁴⁷³ For more details see also Timo Goesl and Timothy Swanson (1996), "Market Imperfections and Crop Genetic Resources", Paper prepared for the International Plant Genetic Resources Institute. Rome : IPGRI

the apparition of a notion of “Farmers” rights’ in two FAO resolutions interpreting the International Undertaking.

3.2.1.2 Land Conversion and the Role of Biodiverse Countries

If the concept of farmers rights attempts to answer the phenomenon of specialization by considering economic incentives for some farmers to carry on cultivating a large range of species and varieties, the main cause of biodiversity erosion is probably land conversion. Land Conversion is the process by which human societies convert naturally existing lands to other land uses that are more highly valued by humans. Over the past ten thousand years, human societies have reallocated land towards a very small selection of species. These are the domesticated and cultivated varieties that have been developed for use in agriculture. Thus, through this conversion process, human societies and their associated species have expanded while reducing the resources available to other species. Therefore, the human development process has been closely related with diversity decline over the past ten thousand years. Today, highly developed countries have lost a good part of their biodiversity and most of the remaining biodiversity lies in tropical developing countries.

As a consequence, one of the main costs of biodiversity conservation is the opportunity cost of not converting extra land. The public goods problem appears in the fact that even if the social benefits of conserving biodiversity are higher than the social benefits of additional conversion and specialization, the private benefits for a state considering the latter are much higher than the private benefit of conservation. Within the territory of a state, the government can either provide some public funding for biodiversity conservation or create property rights to enable conservators to appropriate the returns on their investment. However, as most of the remaining biodiversity is in a limited number of developing countries, most of the conservation efforts must be carried out within their territory for the benefit of all mankind, and more specifically for the benefits of user countries and their industries. There is, therefore, a need to channel the benefits (or internalize the social benefit) of biodiversity conservation to those countries. This issue was first considered in the three resolutions adapted by the FAO before becoming a central issue of the Convention on Biological Diversity.

3.2.2 Legal Changes

Resolutions 4/89 and 5/89⁴⁷⁴ introduce the idea that the sources of or inputs to innovation – developing countries' genetic resources – deserve compensation and emphasize the role of farmers. Resolution 4/89 provides that *States adhering to the Undertaking recognize the enormous contribution that farmers of all regions have made to the conservation and development of plant genetic resources, which constitute the basis of plant production throughout the world, and which form the basis for the concept of Farmers' Rights*. The rationale for a possible compensation is further explained in Resolution 5/89 that considers that *in the history of mankind, unnumbered generations of farmers have conserved, improved and made available plant genetic resources and that the majority of these plant genetic resources come from developing countries, the contribution of whose farmers has not been sufficiently recognized or rewarded*. As a consequence, Resolution 5/89 endorses the concept of Farmers' Rights defined as *rights arising from the past, present and future contribution of farmers in conserving, improving and making available plant genetic resources, particularly those in the centers of origin diversity*.

Apart from acknowledging the role of farmers and enouncing the rationale for their compensation, resolutions 4/89 and 5/89 observe that farmers are both at the source and at the end of the conservation and innovation chain: they conserve genetic diversity and provide the inputs to the innovation chain; by cultivating the new crops they are also the end users of the conservation and innovation efforts. So, Resolution 4/89 specifies that *the best way to implement the concept of Farmers' Right is to ensure the conservation, the management and the use of plant genetic resources, for the benefit of present and future generations of farmers*. Resolution 5/89 adds that Farmers' Rights should *allow farmers, their communities, and countries in all regions, to participate fully in the benefits derived, at present and in the future, from the improved use of plant genetic resources, through plant breeding and other scientific methods*.

⁴⁷⁴ FAO Conference Resolution 5/89, it is an annex to the International Undertaking; Adopted 29 November 1989; 25 Session of the FAO Conference; FAO, Rome.

3.2.2.1 Farmer's Rights: Considering Liability Rules⁴⁷⁵ and Collective Rights Organizations.

Once the rationale for compensating traditional farmers as conservationists and input providers is set, the design of a compensatory mechanism remains. Unfortunately, on this aspect the two resolutions provide little detail. However, they give some clues on how such a compensatory system could be designed. First, Resolution 4/89 provides a new interpretation of the notion of *free access* stating that *the term "free access" does not mean free of charge*. Second, it adds that *the benefits to be derived under the International Undertaking are part of a reciprocal system, and should be limited to countries adhering to the International Undertaking*. Third, Resolution 5/89 vests Farmers' Rights in the international community as trustee for present and future generation of farmers. And fourth, the ulterior Resolution 3/91⁴⁷⁶ provides that Farmers' Rights will be implemented through an international fund on plant genetic resources which will support conservation and utilization programs.

Because the international community will not implement Farmers' Rights, they cannot really be regarded as a legal device. However, since the adoption of those resolutions, they remain a mobilizing political concept. The idea of compensating farmers and developing countries for their contribution in to conservation and innovation will later be implemented through different devices. It is nonetheless worth trying to figure out what kind of device(s), Resolution 4/89 and 5/89 call for.

The assertion that *free access*⁴⁷⁷ *does not mean free of charge*, points towards the creation of an entitlement protected by a **liability rule** and the constitution of a form of a **paying public domain**. Indeed, in the first part of this dissertation, it has been said that an entitlement is deemed to be protected by a liability rule whenever someone may take the entitlement if he is willing to pay an objectively (collectively) determined value for it. A liability rule does not require a prior agreement of the entitlement holder. Thus, it can be said that an entitlement protected by

⁴⁷⁵ For another text suggesting an analysis of Farmers' Rights in terms of liability rules, see Valerie Boisvert and Emmanuelle Caron (1998), "Biodiversity and Property Rights: The Contributions of a Neo-institutional Approach", Second International Conference of the European Society for Ecological Economics 4th-7th March, University of Geneva, Switzerland.

⁴⁷⁶ FAO Conference Resolution 3/91 is the third annex to the International Undertaking; Adopted 25 November 1991; 26 Session of the FAO Conference; FAO, Rome.

⁴⁷⁷ As the word "free" can imply either no price or no prior consent, the expression "Open access" would have been clearer than free access

a liability rule is in *free access but not free of charge* as said by Resolution 4/89. The creation of an entitlement –a Farmers' Right – protected by a liability rule requires some collective decisions on the following questions. Like for any intellectual property rights, one must know who is entitled to it, and the acts that trigger an obligation to compensate. In addition, protecting an entitlement by a liability rule requires a mechanism of collective evaluation of the compensation. The answers provided by the resolution are confusing because there seems to be a juxtaposition of two compensation systems.

The first compensation system lies in the possibility of genetic resources holders claiming compensation when asked to provide access to their resources. In this case, the entitlement holder is the holder of the resources whose access is requested. The debtor of the compensation is the one asking access to the genetic resources. But, the mechanism of collective evaluation is missing. Indeed, little is said about the amount that can be charged but one can think that it is only necessary to compensate the cost of transferring the resources plus part of the cost of their conservation, though it could by no means threaten the principle of open-access.

Regarding the second system of compensation, the resolutions ask for the creation of an international fund that would finance conservation and utilization programs for the benefit of farmers. This fund would be supplied by user-country contributions. Thus, in this system, farmers collectively hold the entitlement, while their rights are vested in trust by the international community, which is in charge of collecting and managing the funds. The asymmetry between biodiversity rich and technologically poor countries (providers) and biodiversity poor and technologically rich countries (users) triggers an obligation to compensate. The use of a trust fund, and the fact that it is due to be fed by user countries, eliminates the necessity to precisely identify an individual provider and an individual user in each accession to genetic resources. However, it requires specifying contributions and distribution rules. If those rules had been specified, the system could have looked like a **collective rights organization**, but the resolutions are mute on these issues. Actually, this second system looks more like solidarity among nations rather than a collective rights organization or a true liability rule.

In addition to this suggestion for a compensation mechanism for farmers, the resolutions claim that the benefits of the open-access regime are part of a reciprocal system and call for the limitation of the open-access principle to countries adhering to the IU. In so stating,

Resolution 4/89 suggests that a regime of **shared access** (limited commons or *res universitatis*) based on reciprocal obligations might be better than an open-access regime (or public domain or *res publicae*). Because access is conditioned by a series of reciprocal obligations, it is an incentive for would-be users to provide their contributions. In other words, moving from an open-access regime to a shared-access regime could be viewed as a means to reduce free riding. Like the two previous provisions, this provision has never had any effect.

3.2.2.2 National Sovereignty: Opting for a Property Rule

As a matter of fact, neither the potential of a liability rule nor that of a shared access regime will be explored because genetic resources quickly evolve to a more proprietary regime. While users ask for new intellectual property rights to their innovations, states will claim national sovereignty over their genetic resources. In its next Conference, the FAO adopted a new Resolution 3/91 in which it asserts that the concept of common heritage as applied to genetic resources is submitted to the national sovereignty of states over their resources. Even so, if the expression common heritage is maintained, the assertion of sovereign rights on genetic resources puts an end to the open-access regime. One year later, the Convention on Biological diversity was signed at the Earth Summit in Rio de Janeiro, Brazil. This legally binding treaty removes all references to the notion of Common Heritage and vests biodiverse countries with national sovereignty over their genetic resources. National sovereignty can be a way for those countries to negotiate access to their genetic resources, and in so doing, appropriate some of the benefits of their conservation efforts.⁴⁷⁸ It is, therefore, an attempt to solve a public goods problem through the creation of property rights.⁴⁷⁹

⁴⁷⁸In addition, the move from the common heritage doctrine towards national sovereignty is politically facilitated by the notion of permanent national sovereignty on natural resources that appeared as a cornerstone of development law. See notably Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques...", pp. 42-44

⁴⁷⁹ An alternative solution could have consisted in vertical integration. Biodiversity conservation and biotechnological inventions form an innovation chain. The patenting of biotechnological inventions enables to appropriate some benefits of the innovation chain. Consequently, one possibility to fund biodiversity conservation could consist in the vertical integration of the innovation chain. Either biodiversity rich countries could develop a biotech industry or biotech industries could invest in the purchasing of land in biodiverse countries for conservation purposes. Nevertheless, these two variants of vertical integration are unlikely to happen. As for the first one, most biodiverse countries are developing countries with little technical capacities; they are thus unlikely to develop their own biotech industries in the short run. However, emerging countries

In legal terms, it might seem strange to compare the notion of national sovereignty with the concepts of property rights or intellectual property rights. Nevertheless, the practical effect and the economic rationale of vesting states with national sovereignty over their genetic resources share some common traits with property rights and intellectual property rights. To some extent, national sovereignty on genetic resources includes both fundamental attributes of property rights: exclusivity and transferability. The exclusivity prerogative entitles the holder to the exclusive possession of the right at stake. It is supposed to provide a maximum incentive to invest in resource conservation. This is precisely the objective pursued by the drafters of the Convention. The transferability prerogative enables the holder to transfer the rights at a mutually agreed price and conditions. Such an attribute provides the conditions for an efficient allocation of the concerned right, i.e. its transfer to the economic agent who most values it. As for national sovereignty, it is obviously not transferable but it enables the transfer of genetic resources. The person collecting genetic resources with the authorization of the providing states ends up with a property right to the samples he collects. However, the exclusivity and transferability of the state's rights must be qualified to take into account the role of property on the genetic resources considered. The Convention on Biological Diversity does not affect property law, and as a consequence if someone wishes to access plants or microorganisms in private land or from land where the management has been committed to a local or an indigenous community, must also obtain permission of the landowners.

Vesting states with national sovereignty over their genetic resources provides them not only with the two main prerogatives of property rights, but also with more specific traits of intellectual property rights. First, national sovereignty and the related right to regulate access to genetic resources is mainly a right to information. Even if Article 15 of the Convention on Biological Diversity recognizes the sovereign rights of states over their natural resources, the rules on access provided by the rest of the article only apply to genetic resources, which are defined as living materials containing functional units of heredity of actual or potential value. That is to say that Article 15 provisions apply to natural

like Brazil, India and China may one day consider that option. Concerning the second variant, one can observe that biotech companies are reluctant to invest in the purchase of large area of land for conservation and R&D purpose notably for reasons of legal certainty see Timothy M. Swanson (1998), "Property Rights Issues Involving Plant Genetic Resources: Implications of Ownership for Economic Efficiency", CSERGE Working Paper GEC 98-13

resources when they are used as pieces of useful information in a R&D process but not when they are used as a product for direct consumption (e.g. construction wood or game). Another important trait that national sovereignty has in common with intellectual property rights is that they both enable the holder to control some uses of the goods subject to these rights even after the transfer of the good to a third person. So, a patentee can sell the machine he invented but he retains the exclusive right to manufacture it. In a similar way, a state can sell plants containing genetic resources, and if the state transfers the full ownership of the individual plants, it continues to retain some rights over the use of genetic resources and their informational content.⁴⁸⁰

In this chapter, I have described legal changes both upstream and downstream of the innovation chain that put an end to the open-access regime for genetic resources and replace it with a regime based on exclusive rights. This new regime is regulated by the Convention on Biological Diversity, which I mentioned above. It is now time to dedicate it a chapter. In the following Chapter, I will examine the provisions of the Convention regarding access to genetic resources and benefit sharing. I will then describe how it has been implemented by governments and try to provide an assessment of the new regime a decade after its entry.

⁴⁸⁰ The precise extend of these control will finally be determined by the terms of the contract between the providing state and the user. Indeed, it seems clear that states keep some control on any product containing some of their genetic resources. By contrast, the CBD itself does not mention “derivatives” such as semi-synthesized or totally synthesized compounds based on structures discovered from studying genetic resources or sales of hybrid plants that result from access to two-parents.

4. The Convention on Biological Diversity and its Implementation

In the previous chapter, I described two legal changes, (1) the patenting of genetic resources and (2) national sovereignty on genetic resources. Together, these changes effectively put an end to open-access genetic resources and have prepared the coming of the Convention on Biological Diversity ("CBD"). In this chapter, I will present the CBD and assess the first years of its implementation. I start with a general presentation of the CBD before taking a closer look at some of its provisions and the property regime it creates for genetic resources. Then, I discuss the process of national implementation of the Convention, using the Philippines as an illustration. Following this, I suggest a provisory assessment of both the CBD and national ABS legislations, first looking at existing studies on the Philippines situation, and then trying to draw general observations in terms of transaction costs. Finally, I mention a few improvements that have been adopted or that are under consideration.

4.1 Presentation of the CBD

There are two groups of developments that have opened the way for a new property regime for genetic resources that is based on the generalization of exclusive property rights and the negotiation of bilateral agreements between providers and users of genetic resources. These groups of developments are: the evolution of the discussions within the FAO and the negotiation of the three interpretative resolutions on the one hand, and the patenting of genetic resources, the revision of the UPOV Convention and the negotiation of the TRIPs Agreement on the other hand. These new elements will be integrated into the negotiation of the CBD. Signed in 1992 at the Rio Earth Summit and entered into force in December 1993, the CBD codifies and generalizes this new property regime.

In fact, the CBD contains little change in comparison to existing biodiversity-related law. In actuality, the CBD can be seen as both a framework convention and a codification of the existing law. As a framework convention, the CBD, for the first time, gives recognition to and integrates a series of movements implied in the use and conservation

of biodiversity.⁴⁸¹ These movements include the “parks and protected areas movement”⁴⁸² that pursues the creation and maintenance of national parks, the “sustainable utilization movement” pursuing system of controlled utilization of wildlife,⁴⁸³ and the “plant genetic movement.” In each of those movements, there had been independent recognition of the need for economic incentives for conservation, or more precisely the need to align the incentives of national and local decision-makers and individuals with the conservation objectives.⁴⁸⁴ Similarly, Article 1 of the CBD states that the objectives of the convention 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 utilization of genetic resources*. The CBD is also a framework convention in the sense that most of its provisions are not self-executing, they focus on objectives and leave member states space for flexible implementation.⁴⁸⁵ The CBD also provides an institutional framework for further discussions on the integration of those movements and the implementation of their objectives. As for the precise content of the CBD text, it represents little more than a codification of the existing law. Concerning plant genetic resources, the CBD codifies the different bodies of law that I mentioned earlier and extends their application.

On the one hand, the CBD’s article 16 on *Access to and Transfer of Technology*, takes note of the possibility to obtain intellectual property rights on genetic resources, and more broadly biotechnological inventions in most developed countries. It also takes note of its future geographical extension to all members of the WTO as required by the

⁴⁸¹ Timothy M. Swanson (1997), *Global Action for Biodiversity...*, p. 81

⁴⁸² See CBD article 8. Since long, there have been numerous protected areas in colonial Africa and North Africa. The movement was revitalized in 1962 with the First World Park Conference in Seattle, USA under the supervision of the International Union for the Conservation of Nature and Natural Resources (IUCN). Since then, the practice of designating and protecting areas under the IUCN system has become universal with around 37.000 sites covering around 8 million square kilometers, or 4% of the unconverted area habitats.

⁴⁸³ See CBD article 10 and the Convention on International Trade in Endangered Species (CITES) signed in Washington, DC, in 1972.

⁴⁸⁴ Timothy M. Swanson (1997), *Global Action for Biodiversity...*, p. 81

⁴⁸⁵ Francoise Burhenne-Guilmin (1998), “L’accès aux ressources génétiques: les suites de l’article 15 de la Convention sur la Diversité Biologique” in Michel Prieur et Claude Lambrechts (eds.) *Les Hommes et L’Environnement, Quels droits pour le vingt-et-unième siècle ? Etudes en Hommages à Alexandre Kiss*, Frison-Roche, Paris, p. 551 ; hereafter Francoise Burhenne-Guilmin (1998), “L’accès aux ressources génétiques...”

coming TRIPS Agreement.⁴⁸⁶ On the other hand, the CBD reaffirms (preamble) and recognizes (article 16) the sovereign rights of States over their natural resources and their authority to determine access to their genetic resources.

There is little to add regarding the patenting of genetic resources that has not already been described at length in the previous chapter and in the first part of this dissertation. In addition, the CBD is not the source of this evolution, it merely adapts to it. Conversely, there is more to say about state sovereignty over their natural resources and particularly their genetic resources. Even if the assertion of sovereign rights over genetic resources was already present in the FAO Resolution 3/91, the CBD extends the scope of the notion, both in terms of subject matter (*ratione materiae*) and in terms of contracting parties (*ratione personae*). While the FAO resolution only concerned the states adhering to the International Undertaking and a limited range of genetic resources used in the agriculture and food industry, the CBD covers all vegetal and animal genetic resources and applies to almost all states.⁴⁸⁷ In addition, unlike the International Undertaking and its interpretative resolutions, the CBD is a legally binding treaty applying to almost all states and it is considered to be the founding text for the recognition of state sovereignty over genetic resources. Finally, the CBD gives more precision on the notion of national sovereignty over such goods as genetic resources and provides a forum for further discussion on its implications.

4.2 The Text of the CBD

Given the direction taken in the FAO and the arguments previously explained, the Convention logically reasserts state sovereignty over their genetic resources. The Preamble of the Convention goes one step further than the FAO, and conscientiously avoids restating the Common Heritage principle. Rather, the Preamble refers to biodiversity conservation as the “common concern of humankind,” in order to dilute the idea of collective ownership that is implied in the expression “Common Heritage.”⁴⁸⁸ Article 15, is the main provision of the

⁴⁸⁶ The TRIPs Agreement is only signed in 1994 with the rest of the Marrakech Agreements and entered into vigor in 1995 but it has been negotiated for years and its content was partly known at the time of the negotiation of the CBD.

⁴⁸⁷ There are now 188 contracting parties (June 2006).

⁴⁸⁸ David Tilford (1998) “Saving the blueprints: The International Legal Regime for Plant Resources”, 30 CASE WESTERN RESERVE JOURNAL OF INTERNATIONAL LAW 373, at 414

Convention concerning the rights and obligations of states over access to genetic resources and the uses of these resources.

The main elements can be summarized as follows. First, Paragraph 1 recognizes the sovereign rights of states over their natural resources and makes it clear that the authority to grant access to genetic resources rests with national governments and is subject to national legislation. Consequently, states have the right to regulate access to their genetic resources and to enjoy a great deal of discretion in detailing access conditions. Second, Paragraphs 4 and 5 contain some important principles on the general conditions on which access to genetic resources can be made dependent. By conditioning access on attaining *mutually agreed terms*, Paragraph 4 calls for the negotiation between the country granting access to genetic resources and an individual, company or institution seeking access to genetic resources. Under Paragraph 5, access to genetic resources may be subject to the *prior informed consent* of the state providing the genetic resources. The notion of prior informed consent contains at least two elements; if the providing state chooses the option to rule access to its genetic resources, its consent must be obtained before accessing genetic resources and the party interested in access to genetic resources must provide information on the subsequent use of those resources. The expression prior informed consent thus calls for a system of licenses of access with a procedure detailing the information required before access is granted.⁴⁸⁹ Third, Paragraph 7 provides that each contracting party shall take appropriate measures with the aim of sharing the results of R&D and the benefits arising from the utilization of genetic resources with the providing state. However, regulation of access must enable benefit sharing but not hinder access; indeed Paragraph 2 requires all member states *to endeavor to create facilitated access to genetic resources*. Finally, Paragraph 3 limits Article 15 domain of application to genetic resources collected after the CBD comes into force. As a consequence, owners of *ex situ* collections of genetic resources, botanical gardens or pharmaceutical companies, may continue to use their collections without being subject to the convention.

4.3 ABS Legislation: the Case of the Philippines

If Article 15 of the CBD vests states with national sovereignty over their genetic resources, the authority to determine access rests with the national government and is subject to national legislation. A decade after

⁴⁸⁹ Francoise Burhenne-Guilmin (1998), "L'accès aux ressources génétiques...", p. 552

the CBD's entry into force, about fifty countries have adopted, or are developing access and benefit sharing (ABS) measures⁴⁹⁰ at the regional, national or local level. As it is impossible to present every national legislative measure, I will focus on the legislation in the Philippines as an example. In 1996, the Philippines became the first country to convert the CBD into national law, and it has subsequently inspired other legislation. Because the Philippine legislation has been in application for ten years, it is possible to assess the first years of application. After describing the legislation, I will briefly mention some bioprospecting contracts that were negotiated under its terms. Then, I will broaden the focus and provide some evaluation of the existing ABS legislation and bioprospecting contracts taken from existing cases studies.

The Philippines has a very high rate of biodiversity, however it is declining at an alarming speed. It is estimated that it harbors more than 40,000 wildlife species, which is around five percent of the world's known flora.⁴⁹¹ The value of the country's biodiversity is of particular importance because a great number of species are endemic, which means that they exist only in the Philippines.⁴⁹² This natural heritage is disappearing at an unparallel pace due to an uncontrolled conversion process, in addition to deforestation that leads to the disappearance of ecosystems.⁴⁹³

⁴⁹⁰ Argentina, Australia, Belize, Brazil, Cameroon, Costa Rica, Eritrea, Ethiopia, Fiji, the Gambia, Ghana, Guatemala, India, Indonesia, Kenya, Laos, Lesotho, Malawi, Malaysia, Mexico, Mozambique, Namibia, Nigeria, Papua New Guinea, Philippines, Samoa, Solomon Islands, Seychelles, South Africa, South Korea, Tanzania, Thailand, Turkey, USA, Vietnam, Yemen have a national legislation or are developing it. In addition, the member of the Andean Pact, Bolivia, Columbia Ecuador, Peru, and Venezuela adopted a common legislation. The ASEAN countries are also considering regional access measures while the African Union drafted a model legislation for its members. The text of the existing measures can be found on the website of the CBD secretariat at the following page: <http://www.biodiv.org/programmes/socio-eco/benefit/measures.aspx>

⁴⁹¹ A. Wood et al. (no year) "Socio-economic Root Causes of Biodiversity Loss in the Philippines", Summary

⁴⁹² A.G.N. La Viña, M.J.A. Caleda and M.L.L. Baylon (eds) (1997) *Regulating Access to Biological and Genetic Resources in the Philippines. A manual on the Implementation of the Executive Order No. 247*, Quezon City, p. V

⁴⁹³ Philippines forest cover has been reduced from more than 50% to less than 24% over a period of 40 years; 30% to 50% of its seagrass beds has been lost in the last 50 years; only 5% of its coral reef is still in an excellent conditions and around 80% of its mangrove areas have been lost in the last 75 years. About 50% of national parks are estimated to be no longer biologically important. See C.V. Barber and A.G.M. La Viña (1997) "Regulating Access to Genetic Resources: The Philippines Experiences" p.115-141 in J. Mugabe, C.V. Barber, G. Henne, L. Glowka and A. La Viña (eds.) *Access to Genetic Resources*, WRI, ELC-IUCN, ACTS Press, Nairobi Kenya.

Adopted after a large participatory process,⁴⁹⁴ the 1995 Presidential Executive Order 247 (EO 247) established the legal framework for access to genetic resources.⁴⁹⁵ In 1996, it was complemented by the Department Administrative Order 96-20⁴⁹⁶ (DAO 96-20), which set out the administrative rules implementing EO 247. The provisions of those regulations can be summed up in four points. First, regarding genetic resources property regime, the EO 247 reaffirms the constitutional provision saying that the States owns all forest, wildlife, flora and fauna and other natural resources.⁴⁹⁷ However it also recognizes the rights of indigenous cultural communities and other Philippine communities to their traditional knowledge and practices where this information is directly and indirectly put into commercial use. Research activities in their domains must be in compliance with specific rules. (*cf. infra*)

Second, in terms of implementing organizations, it established an Inter-Agency Committee for Biological and Genetic Resources to coordinate the process of application for access to genetic resources, to monitor the implementation of the research agreements, and to assess the rules.⁴⁹⁸

Third, the regulations organize the procedures to apply for and negotiate a bioprospecting agreement. EO 247 draws a distinction between two categories of agreement: Commercial Research Agreements (CRA) and Academic Research Agreements (ARA). However, the distinction has a limited effect because ARA only concerns domestic academic institutions and intergovernmental agencies and not foreign academic institutions. In addition, the only differences between them consist of allowing more comprehensive agreements, both in terms of prospected areas and duration of the prospecting.⁴⁹⁹ Then, EO 247 details the minimum terms of the CRA and ARA within which the concerned agency and the collector have some freedom to negotiate agreements.

⁴⁹⁴ For an account of this participatory process, see Kristina Swiderska, Elenita Daño and Olivier Dubois (2001), "Developing the Philippines Executive Order 247 On Access to Genetic Resources", published by International Institute For Environment and Development (IIED)

⁴⁹⁵ Philippines, Executive Order No 247 Prescribing Guidelines and Establishing a Regulatory Framework for the Prospecting of Biological and Genetic Resources, their By-products and Derivates, For scientific and Commercial Purposes, and for Other Purposes. The text can be found on the website of the CBD secretariat at the following page: <http://www.biodiv.org/programmes/socio-eco/benefit/measure.aspx>

⁴⁹⁶ The full text of DAO 96-20 is available at www.psdn.org/chmbio

⁴⁹⁷ EO 247, Section 2, article XII

⁴⁹⁸ EO 247, Sections 5, 6 and 8 and DAO 96-20, Sections 10 and 11

⁴⁹⁹ EO 247, Section 3 and 5

DAO 96-20 provides a detailed administrative process to obtain the agreement. These minimum requirements include some information requirements such as the explanation of the purpose of the research, source of funds, duration, and a list of biological and genetic material that will be taken.⁵⁰⁰ In the case where the research activities conducted in Philippines lead to a commercial product, the collector must inform the Philippines government as well as the affected local and indigenous cultural communities.⁵⁰¹ In terms of benefit sharing, the regulations contain both monetary and non-monetary requirements. As for monetary benefit sharing, the collector must be paid a small fixed-fee⁵⁰² and the agreement must include a provision for the payment of royalties to the national government and the private landowners or the local and indigenous community in charge of the prospected land in case a commercial product is derived from the biological and genetic resources taken.⁵⁰³ Non-monetary benefits all loosely relate to technology transfer. The collector is required to deposit a sample of all living specimens collected, he must actively involve Philippine scientists in the collection and research activities, and he is asked to donate research equipment to a Philippine institution.⁵⁰⁴ Finally all commercial products derived from Philippine resources must be made available to the Philippines government and concerned local communities.⁵⁰⁵ In other words, whenever a commercial product is derived from Philippine resources and patented, the Philippines must have a free compulsory license.

Fourth, in addition to the government authorization, the collector must obtain the prior informed consent (PIC) of those in charge of the lands he wants to prospect.⁵⁰⁶ According to the legal status of the area, he must obtain one of: the PIC of the Head of the Local Government unit responsible for collection on communal land, the PIC of the Council of Elders or a recognized head of an indigenous community responsible for ancestral lands,⁵⁰⁷ the PIC of the protected Area Management Board for protected areas,⁵⁰⁸ or the PIC of a private land owner. The collector must obtain a PIC for each region he wants to prospect in. The regulations pay special attention to the PIC of indigenous cultural communities.

⁵⁰⁰ EO 247, Section 4 and DAO 96-20, Section

⁵⁰¹ EO 247, Section 5 (d) and DAO 96-20, Section 8.1.9

⁵⁰² EO 247, Section 5 (j) and (o)

⁵⁰³ EO 247, Sections 5 (e) and DAO 96-20, Section 8.2.2

⁵⁰⁴ EO 247, Section 5 (i) and DAO 96-20, Section 8.2.3

⁵⁰⁵ EO 247, Section 5 (l) and DAO 96-20, Section 8.1.9

⁵⁰⁶ DAO 96-20, Section 7

⁵⁰⁷ EO 247, Section 2 and DAO 96-20, Section 5

⁵⁰⁸ DAO 96-20, Section 4

Both the EO 247 and the DAO 96-20 state that their prior informed consent must be obtained in accordance with the customary practices and mores of the concerned communities. Section 7 of the DAO stipulates detailed procedural requirements to ensure that communities' PIC is validly given. The procedure is made more complicated by the enactment of the 1997 Indigenous Peoples' Rights Act (IPRA) that recognizes, protects, and promotes the rights of indigenous cultural communities. This Act also allows access to biological and genetic resources within ancestral domains in accordance with customary law of indigenous community. The procedure to obtain the consent of the concerned community, however, is not the same but in rather even more demanding. As a legislative act, the IPRA supersedes the Executive Order and essentially replaces it in this regard. Finally, the regulations also contain minimum requirements on conforming to environmental protection law and regulations.

4.4 A Few Years of Application

After having described the contents of the Philippine regulations, I would like to feature several existing case studies on the Philippines to give an account of the initial applications. I will then briefly present one research agreement (bioprospecting contract). Later, I will present a broader analysis of the existing ABS legislation and bioprospecting contracts.

Based on a study conducted by the German Development Institute in 2002,⁵⁰⁹ which came six years after the enactment of the EO 247 and the DAO 96-20, it first appears that the number of applications for research agreements was smaller than expected by the drafters of the regulations. By April 2002, the Inter-Agency Commission for Genetic Resources (IACGR) had received applications for fifteen commercial research agreements (CRA) and twenty academic research agreements (ARA). The number of concluded agreements, however, was even smaller. Out of these thirty-five applications, fifteen did not enter in the scope of EO 247 and were referred to the Protected Areas and Wildlife Bureau

⁵⁰⁹ Klaus Liebig *et al.* (2002) "Governing Biodiversity: Access to Genetic Resources and Approaches to Obtaining Benefits from their Use: The Case of the Philippines", Reports and Working Papers 5/2002, German Development Institute, Bonn. See also Paz J. Benavidez II (2004), "Philippines: Evolving Access and Benefit Sharing Regulations", in Santiago Carrizosa *et al.* (eds.) *Accessing Biodiversity and Sharing the Benefits: Lessons from Implementing the Convention on Biological Diversity*, IUCN Environmental Policy and Law Paper, No 54, Gland, Switzerland pp.153-173

(PAWB) for a free permit; nineteen demanded a research agreement.⁵¹⁰ Out of these nineteen applications, six have been approved by the IACGR, and they have led to bioprospecting contracts. Five of these have been explicitly withdrawn due to applicants complaining about the regulations. Most notably, among the withdrawn applications, there were two from the U.S. National Cancer Institute. The organization probably the world's most experienced in bioprospecting, decided to end existing collaborations and to collect genetic resources in other countries in order to avoid the Philippine regulations. As for the remaining eight applications, it is not clear whether they are still pending or whether they have been withdrawn since applicants have not answered requests for additional documents. Finally, the German Development Institute's study notes that the application process for those approved agreements was lengthy and in some cases took up to three years.

Before analyzing the reasons for the small numbers of agreements concluded, for the purposes of illustration, I will outline the content of two joint agreements. Two commercial research agreements (CRA) have been concluded between the University of Utah, USA, which is the principal collector (PC), the University of the Philippines's Marine Science Institute (UP-MSI), which is the co-collector (CC), and the Department of Agriculture, which assists in the evaluation of research proposal in the areas of agriculture, fishery and other natural resources. The first agreement (CRA 98) concerns the collection of marine sponges and ascidians for research on anti-cancer drugs. The second agreement (CRA 2002), signed in 2002, authorizes the collection and purchase of *marine conus* for research on compounds affecting muscles and nerves that could serve as painkillers.

As for the application procedure, the first agreement (CRA98) was applied for in January 1998, was approved relatively quickly, and signed in June of the same year. As it was a three-year contract, a new agreement was applied for in 2001 and was renewed in 2002. By contrast to the first contract, it took nearly four years to gather all the necessary documents and signatures to have the CRA 2002 approved. Because the research collaboration between UP-MSI (CC) and the University of Utah (PC) had been ongoing since the 1970s, the collector and co-collector obtained a provisional permit while the application was pending. In addition to the authorization form, the collectors had to obtain the PIC of several communities. This meant that they had to hold a public

⁵¹⁰ The 35th application as been referred to another agency according to the terms of the Wildlife Act, enacted in 2001 which modifies the application procedure.

meeting with the local authorities and representatives of each community, and provide an explanation of the procedures, and a detailed presentation of the research project and its objectives. It seems that the communities' members were very reluctant at first but, once the research value for health and environmental conservation was explained, their resistance was partly overcome. Once the communities' PIC's were obtained, there was a need to obtain the signatures of the local authorities. In most cases, obtaining the PIC of the communities and the signatures of the local authorities took much more time than the sixty day period required by the EO 247.⁵¹¹

In terms of benefit sharing, both CRAs contain similar provisions on monetary and non-monetary benefits, and their distributions to the UP-MSI (the Co-collector), the Philippines' government and the local and indigenous communities. So far, the main benefits have gone to UP-MSI under the form of equipment, research training and salaries. In the second CRA, those benefits are estimated at US\$ 73,000 for three years. However, it must be noted that the parties do not consider this funding as being related to the EO 247; they consider it, rather, as a continuation of their research collaboration that started in the 1970s. In the long run, if any invention is made, the royalties will be shared equally between the principal collector and the co-collector. As for the government, it receives no benefits in the short term, except a yearly bioprospecting fee of PhP 10,000 (US\$225). In the medium term, it can expect some capacity building benefits consisting of some conservation training for communities and research training for some government officials. In the long term, the government can expect both technology transfer and monetary benefits. The government will have access to the inventions derived from Philippine genetic resources. For endemic species, the government will also have a compulsory license on all the technologies used to make the invention. In addition, the Philippines must be recognized as the country of origin in all publications and documents mentioning its resources. In case of commercial use of an invention derived from Philippine genetic materials, the Department of Agriculture will get five percent of the net revenue. For the communities, their benefits lie in some training and explanation of the research results. In the case of successful commercialization, they will obtain five percent of the five percent of royalties given to the government. So far, no

⁵¹¹ The description of the two joint agreements is derived from the study carried by Klaus Liebig *et al.* and the cases studies carried out Columbia University School of International and Public Affairs (1999), "Access to Genetic Resources: An Evaluation of the Development and Implementation of Recent Regulation and Access Agreements", Environmental Policy Studies Working Paper #4

commercial product has been developed and as a consequence no royalties have been shared.

Even though the number of applications for access to genetic resources is limited, the Philippine case study confirms that research institutions and pharmaceutical companies are interested in obtaining access to the genetic resources of biodiversity rich countries. However, negotiating access to genetic resources appears difficult and costly. Obtaining the government's agreement and the PIC of communities or local authorities requires potential users going through lengthy procedures that can be discouraging. In addition, some potential users reported fear of the EO 247 provision that creates the possibility of a compulsory license on potential inventions. From the standpoint of providing countries, drafting an ABS regulation after an important participatory process and the organization of an administrative procedure constitutes an important cost. Finally, in terms of benefit sharing, the Philippine case study reveals that monetary benefits are limited to a (very) small upfront payment and the hope of royalties in the case of the commercialization of an invention. As a consequence, bioprospecting contracts seem to provide limited or no funding for biodiversity conservation. However, there are some non-monetary benefits under some forms of technology transfer. More precisely, the main benefit for the providing country seems to lie in the creation of a joint venture between the foreign user and a domestic research institution. This joint venture helps to develop the domestic R&D capacities. In addition, improved domestic research capacities might increase interest in conserving the domestic biodiversity.

4.5 Limited Success and Transaction Costs

The Philippines are only one of many countries that have enacted or consider enacting ABS legislation. Similar observations have been made in a large number of cases studies⁵¹² and in several OECD Reports⁵¹³ in

⁵¹² It is not possible to draw here an exhaustive list of existing cases studies but I can mention some collective surveys that gather several cases studies. First, the secretariat of the CBD has collected a series of case studies that are available at <http://www.biodiv.org/programmes/socio-eco/benefit/cs.aspx>. Second, the collective study carried out by Columbia University already mentioned and available at the same address; and Santiago Carrizosa *et al.* (eds.) *Accessing Biodiversity and Sharing the Benefits: Lessons from Implementing the Convention on Biological Diversity*, IUCN Environmental Policy and Law Paper, No 54, Gland, Switzerland.

⁵¹³ OECD (2003), *Economic Issues in Access and Benefit Sharing of Genetic Resources: A Framework of analysis*, ENV/EPOC/GSP/BIO(2001)/FINAL, Paris and OECD (1996),

addition to the very detailed study done by Kerry Ten Kate and Sarah Laird on the *Commercial Use of Biodiversity*.⁵¹⁴ Most of the impediments to negotiating bioprospecting agreements can be framed in terms of transaction costs. In the next paragraphs I examine those hindrances in further detail and order them according to different types of transaction costs. As has been described above, transaction costs can be divided in four main categories: search costs, bargaining costs, monitoring costs and enforcement costs.

Search costs designate the costs of locating an exchange partner, that is to say identifying a person who wants to sell what you want to buy or buy what you want to sell. As for bioprospecting, search costs are likely to be high for two reasons. First, genetic resources are not standard goods with well-identified characteristics and well-known sellers. The identification of interesting genetic resources gives unpredictable results. Potential users know that they will probably have to screen thousands of samples in order to identify a few promising compounds that might lead to a valuable invention. In addition, genetic resource providers and users give little information on who has what to sell. In contrast to *ex situ* collections where genetic resources are well classified and documented, *in situ* genetic resources are undocumented and for a good part still unknown.⁵¹⁵ Second, search costs might be high because once the potential user has identified the country in which he wants to collect resources, he still has to identify the “seller,” or more precisely all the persons whose permission he needs to obtain, and he must go through complex and unclear procedures.

Bargaining costs designate the costs of reaching an agreement. As explained earlier, the parties are likely to find an agreement in what game theorists call “common knowledge” situations, that is to say, when the parties can easily identify their mutual threat value and the possible cooperative surplus.⁵¹⁶ In these situations, information is said to be public. Conversely, information is “private” when one party knows some

Issues in the Sharing of Benefits Arising out of the Utilization of Genetic Resources, OCDE/GD(97)193, Paris

⁵¹⁴ Kerry Ten Kate and Sarah Laird (1999), *The Commercial Use of Biodiversity: access to genetic resources and benefit-sharing*, London: Earthscan; hereafter Ten Kate and Laird (1999), *The Commercial Use of Biodiversity* (...).

⁵¹⁵ We will see in Part Three that traditional knowledge detained by local and indigenous communities can substitute documentation and facilitate the identification of interesting plants and their potential uses.

⁵¹⁶ In this case, threat values are the lowest price the seller is ready to accept and the highest price the buyer is ready to pay; the cooperative surplus is the difference between the two threat values.

of these values and the other does not. Situations where all the parties do not hold all of the information are also referred as information asymmetries. Negotiations tend to be more difficult when information about threat values and cooperative surplus is private. Private information hinders bargaining because it must be made public before the parties can evaluate reasonable terms for cooperation.⁵¹⁷ Parties may be willing to share part of their private information; but they may want to retain some of their information as their part of the cooperative surplus depends to some extent on keeping information private. Private information is not an important issue for standard goods with well-identified characteristics. By contrast, in the case of bioprospecting agreements two-sided private information is common. On the side of genetic resource users, the private information may include knowledge on the potential uses of genetic resources, on the cost of R&D, on possible alternative providers, or alternative technologies. In addition, genetic resources are complex goods and providing countries often have limited capacities to identify their uses and values. On the providers' side, there might also be some private information about the reliability, quality and diversity of the information and samples to be provided.⁵¹⁸ To overcome valuation problems and the cost of turning private information into public information, the parties can relinquish up-front payment, partially or totally. In such cases the parties can resort to *ex-post* compensation through a share of the royalties in cases where a commercially successful invention is derived from the genetic resources. Sometimes, the level of royalties is settled in the contract, sometimes it is left for further negotiations. This strategy has been followed in the Philippine case and most other existing bioprospecting contracts. It is worth mentioning that this strategy is related to the one followed by research institutions holding upstream patents that overcome the valuation problem by resorting to "reach through license agreements" or "grant back licenses" (Cf. Part I, chapter 4). The general advantage of such a solution is that the level of compensation (i.e. the price) is fixed when the parties disposes of more information on the value of the provided genetic resources. In addition, the use of royalties creates a link between the value of genetic resources and the level of compensation. Finally, when the determination of the level of royalty is postponed to further negotiations, it reduces bargaining costs as the parties must only negotiate compensation in the limited number of cases where a commercially successful invention is made. However, this solution has

⁵¹⁷ Robert Cooter and Thomas Ulen (2004), *Law and Economics*, Fourth Edition, Addison-Wesley, p. 92

⁵¹⁸ OECD (2001), *Economic Issues in Access and Benefit Sharing of Genetic Resources: A Framework of analysis*, ENV/EPOC/GSP/BIO(2001)/FINAL, Paris, p. 16

limits. Indeed, it only reduces and to some extent postpones the bargaining problem. More importantly, it might effectively turn bargaining costs into monitoring costs because the providing country will have to track its genetic resources through the R&D process and possibly across different corporations or other research institutions.

Other obstacles to bargaining are cultural differences or lack of trust. Cultural heterogeneity and suspicion within the “bioprospecting community,” i.e. pharmaceutical companies, research institutions, national governments, and local and indigenous communities complicate the search for mutually agreed terms,⁵¹⁹ a bit like the licensing of upstream patents (*Cf. Part I, chapter 4*).

Finally, bargaining costs tend to rise as the number of involved parties increases. At first glance, it should not be an issue because bioprospecting agreements are bilateral contracts. However, bioprospecting often implies more than one contract and two parties. As for the number of negotiating parties, there is a tension between the need to minimize the number of parties to facilitate the establishment of agreements and the wish to implicate all stakeholders and their interests.⁵²⁰ Indeed, failure to involve all stakeholders has already jeopardized the conclusion or the implementation of some contracts.⁵²¹

Monitoring and Enforcement costs occur when an agreement takes time to fulfill; they include the costs of monitoring behavior and sanctioning violations of the contract. Monitoring the agreement is difficult because it involves tracking genetic resources through the R&D chain. In some situations, the degree of transformation of genetic resources is such that it becomes hardly possible to track them in the innovation chain.⁵²² Then, once an invention is made and commercialized, it is costly for the provider to verify the extent of the commercial success including the level of sales and all the costs that

⁵¹⁹ For some testimonies on the “environment of suspicion”, see Rex Dalton (2004), “Bioprospects...”, p. 598 or Ten Kate and Laird (1999), *The Commercial Use of Biodiversity*, p. 296

⁵²⁰ Columbia University School of International and Public Affairs (1999), “Access to Genetic Resources: An Evaluation of the Development and Implementation of Recent Regulation and Access Agreements”, Environmental Policy Studies Working Paper #4

⁵²¹ Personal communication with Brendan Tobin about the negotiation of bioprospecting contract with Monsanto in Peru.

⁵²² For a detailed account of these transformations and their consequences on bioprospecting contracts see Bronwyn Parry (2004) *Trading the Genome, Investigating the Commodification of Bio-Information*, New York: Columbia University Press

contribute to developing and selling the product.⁵²³ Actually, providing countries must not only monitor the fulfillment of contracts, they must also enforce their ABS legislation. This implies the capacity to track and monitor the use of genetic resources, which seems peculiarly difficult for this type of goods. In addition, genetic resources are easy to collect and for decades scientists have practiced “informal” bioprospecting, collecting resources without permit when attending a conference or on holiday. In 2000, for instance, three French scientists disguised as ecotourists were caught in the Philippines trying to smuggle medicinal plants.⁵²⁴ Finally, sanctioning the violation of the agreement or violation of the ABS legislation often implies suing the violator in his country, which can be costly by comparison with the value of concerned genetic resources.

In addition to those transaction costs, one must add the **administrative costs** incurred by the providing countries that have to enact regulations and develop administrative capacities to deal with the negotiation of ABS agreements, the monitoring of compliance, and the sanctioning of possible violations. So far, for many countries, the balance of administrative costs and benefits is negative, which may tend towards a preference for renouncing any enactment of ABS legislation –this has actually been the choice of most developed countries.

Since the CBD’s 1993 entry into force, the data shows that some pharmaceutical companies have withdrawn from bioprospecting while others have enhanced their collecting programs. However, the net effect has been a **decrease in bioprospecting** activity to a historically low level.⁵²⁵ From interviews of potential users it appears that transaction costs and legal uncertainty are the main reasons for this reduction. Actually, it appears that bioprospecting is partly in competition with other technical solutions such as resorting to *ex situ* collections or increased use of synthesized compounds.⁵²⁶ Changes in the cost of one solution are likely to produce a shift in the proportional use of the available alternatives. In addition to the reduction of the bioprospecting activity, interested companies are becoming more selective about the

⁵²³ OECD (2001), *Economic Issues in Access and Benefit Sharing of Genetic Resources: A Framework of analysis*, ENV/EPOC/GSP/BIO(2001)/FINAL, Paris, p. 16

⁵²⁴ Rex Dalton (2004), “Bioprospects less than golden” 429 NATURE 598, hereafter Rex Dalton (2004), “Bioprospects...”

⁵²⁵ Ten Kate and Laird (1999), *The Commercial Use of Biodiversity*, pp. 298 and 300, and Rex Dalton (2004), “Bioprospects less ...”, p. 598

⁵²⁶ Ten Kate and Laird (1999), *The Commercial Use of Biodiversity*, pp. 300 and 302

countries where they collect genetic resources and the types of resources they collect.⁵²⁷ Several companies report avoiding countries with legislation that is unclear or too demanding.⁵²⁸ In addition, it seems that the expectations, in terms of providing funds for conservation, are not fulfilled. Not only have bio-diverse countries obtained modest benefits, but only part of the benefits obtained have been invested in conservation efforts.⁵²⁹

In conclusion, it appears that despite the efforts for designing well-defined property rights, there is no such thing as a genetic resource market with well-identified sellers and buyers, well-informed parties (clear threat value and clear bargaining surplus) and well-defined property rights. Rather, it is clear that the negotiation of a limited number of long term contracts with little in common with the instant sale of genetic resource samples.⁵³⁰ These contracts look like R&D joint-ventures, and constitute attempts to integrate providers into the users' research activities.⁵³¹ Benefit sharing under the form of technology transfers (provision of research material and research training) enables providers to deliver more carefully selected genetic resources and useful information on possible uses. In other words, providers are assigned to carry out the first stages of the R&D. It is worth mentioning that these R&D collaborations between pharmaceutical or biotech companies and the providing countries are in many aspects similar to the research cooperation contracts between universities and the same private companies that have flourished since the enactment of the Bayh-Dole Act and similar legislation.

4.6 A Few Existing or Possible Improvements.

As I said at the beginning of this chapter, the Convention on Biological Diversity only outlines the framework for an access and benefit (ABS) regime. Even if access to genetic resources is regulated by bilateral

⁵²⁷ *Ibidem*, p. 58

⁵²⁸ *Ibidem*, p. 301

⁵²⁹ See OECD (2003), *Economic Issues in Access and Benefit Sharing of Genetic Resources: A Framework of analysis*, ENV/EPOC/GSP/BIO(2001)/FINAL, Paris, p. 55

⁵³⁰ For an analysis of these long term contracts in light of Williamson's new institutional economics see Padmashree Gehl Sampath (2005), *Regulating Bioprospecting: Institutions for Drug Research, Access and Benefit Sharing*, United Nations University Press

⁵³¹ *Ibidem*, pp. 58, 60, 69, and Frédéric Morin (2003), "Les accords de Bioprospection répondent-ils aux objectifs de la Convention sur la Diversité Biologique" *REVUE DE DROIT DE L'UNIVERSITE DE SHERBROOKE*, vol. 34, No 1, Novembre

contracts, there is room for additional regulations. The main regulation effort has come from providing countries, which have enacted ABS legislation. Two observations can be made more than a decade after the entry into force of the CBD. First, it is increasingly obvious that access and benefit sharing should not be facilitated and regulated solely by providing countries but it should also be facilitated and regulated by users and their countries. Second, due to important transaction costs, today's regulations reduce access to genetic resources thus providing limited benefits incentives to conserve biodiversity.

In the following paragraphs, I mention some existing or possible improvements. I distinguish measures by their authors and the type of transaction costs they are likely to reduce. Regarding measures taken by providing countries, I continue to illustrate them with the example of how the Philippines modified its regulation of ABS to address the many critics of the Presidential Executive Order 247 (EO 247) and the Department Administrative Order 96-20 (DAO 96-20). On July 2001, The Philippines legislature enacted Republic Act No. 9147, also called the Wildlife Act,⁵³² which removed bioprospecting for (non-commercial) scientific purposes from EO-247 jurisdiction and called for the redaction of new bioprospecting guidelines. On January 12, 2005 the Philippines Government approved the new Guidelines for Bioprospecting Activities in the Philippines.⁵³³

Regarding **search costs**, there is an increasing awareness among providing countries that they have to simplify the process of application and negotiation of a bioprospecting contract, notably by identifying clearly who is competent to negotiate the terms of the contract and give access to genetic resources. In this direction, the new Philippines guidelines slightly simplify the procedure and designate one main interlocutor for users requesting access.⁵³⁴

As for **bargaining costs**, I distinguish three kinds of measures according to their initiators. The conference of the parties to the CBD,

⁵³² The text of the Wildlife Act is available on the CBD Secretariat website at <http://www.biodiv.org/programmes/socio-eco/benefit/measures.aspx>

⁵³³ Joint DENR-DA-PCSD-NCIP Administrative Order No1 Series of 2004. The Text of the Guidelines should be available at the previous address, meanwhile it is now available at : http://www.pawb.gov.ph/posted_files/O.1_Joint%20DENR-DA-PCSD-NCIP%20AO%20No.%201%20signed%2001-12-05.pdf

⁵³⁴ The Secretary of the Department of Agriculture or/and the Secretary of the Department of Environment and natural resources seem in charge of the all process and must organize all the necessary consultation within the different Philippines administration.

that is to say both user's countries and providing countries, adopted the *Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of Their Utilization*.⁵³⁵ These voluntary guidelines are meant to assist governments and other stakeholders when establishing legislative, administrative or policy measures on access and benefit sharing and/or when negotiating contractual arrangements for access and benefit sharing. They contain a kind of checklist of issues and provisions that should be considered in ABS legislation and contracts. They do not constitute an international regime or a standard contract but they offer the possibility for sharing and harmonizing practices. They are also likely to be progressively improved by the conference of the parties.

Other initiatives are taken by users to deal with bargaining costs. First, more and more users resort to intermediaries to access genetic resources. Actually, Sarah Laird observes that *almost without exception, every biodiversity-prospecting collection effort undertaken on behalf of companies is done through intermediaries. In most cases, these are research institutions, botanic gardens and universities [...] because biodiversity prospecting is at heart a scientific undertaking. [...] A number of for profit firms specializing in providing genetic material to the private sector have also appeared in recent years.*⁵³⁶ These intermediary organizations can facilitate the negotiation of bioprospecting contracts: using their expertise and their intermediary position to reduce asymmetry of information, and accumulating experience and reputation to overcome the lack of trust and cultural heterogeneities. Intermediaries can also possibly reduce search costs by helping identify potential partners and reduce enforcement costs by monitoring the economic sectors involved in bioprospecting related activities.

Second, some users or associations of users⁵³⁷ develop their own policies of access and benefit sharing. In countries where there was/is no ABS legislation these guidelines or ethical codes have facilitated the negotiation of bioprospecting agreements. Sometimes, they serve as a model for future legislation. They can also contribute to overcome lack of trust and cultural heterogeneities.

⁵³⁵ *Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of Their Utilization* adopted by the Conference of the Parties, in The Hague, April 7-19, 2002, Decision VI/24. The text is available on the website of the CBD secretariat at <http://www.biodiv.org/programmes/socio-eco/benefit/bonn.asp>

⁵³⁶ Sara A. Laird (ed.) (2002), *Biodiversity and Traditional Knowledge, Equitable Partnerships in Practice*, Earthscan, London, p. 422

⁵³⁷ E.g. the International Society of Ethnobotany, the American Society of Pharmacognosy and the Society for Economic Botany

Sometimes both phenomena are mixed. For instance, the U.S. National Cancer Institute (NCI) acts as an intermediary –and carries out basic research – between providing countries and private companies likely to develop and market drugs. It also develops its own policy to facilitate negotiations with providing countries and between providing countries and private companies. It started in 1988 with a *Letter of Intent* where providing countries acted only as suppliers of genetic resources. Then, building on experience and long-term relationship with those countries, it moved in 1992 to a *letter of collect*; 1995 it moved to a *Memorandum of Understanding*, each time increasing the implication of providing countries in the research process, sharing intellectual property and forcing private partners interested by research results to negotiate benefit sharing with the concerned providing country.⁵³⁸

Initiatives to reduce bargaining costs can also come from providing countries that can attempt to simplify their procedures of access. For instance, the new Philippine guidelines provide default provisions and minimum requirements in terms of benefit sharing between users and the Philippines and among Philippine stakeholders. Default provisions may reduce bargaining costs, it remains however to see whether users will be interested by the minimum requirements.

Bioprospecting contracts involve important **monitoring and enforcement costs**. Monitoring the respect of the agreement is difficult because it involves tracking genetic resources throughout the entire R&D chain. To facilitate this monitoring and to share the burden between the providing country and the users' country; two proposals emerged that sought to link ABS legislations and contracts with IPRs application procedure. The first proposal consists in demanding patent or plant breeders' right applicants to disclose the origin of the genetic resources included in their invention.⁵³⁹ This disclosure of origin should

⁵³⁸ For a detailed analysis of the National Cancer Institute Policy see Kerry Ten Kate and Adrian Wells, "The Access and Benefit Sharing Policies of the United States National Cancer Institute: A Comparative Account of the Discovery and Development of the Drugs Calanoides and Topotecan", Submission to the Executive Secretary of the Convention on Biological Diversity by the Royal Botanic Garden, Kew, available on the website of the Secretariat at <http://www.biodiv.org/doc/case-studies/default.asp>

⁵³⁹ F. Hendrickx, V. Koester and C. Prip (1994), "Access to Genetic Resources: A Legal Analysis" in Vicente Sanchez and Calestous Juma (eds.) *Biodiplomacy, Genetic Resources and International Relations*, Nairobi: ACTS. See also the proposition of Switzerland suggesting to amend the Regulations Under the Patent Cooperation Treaty (PCT) to explicitly enable the Contracting Parties of the PCT to require patent applicants to declare the source of genetic resources and traditional knowledge, if an invention is directly based on such resources or knowledge, WIPO-documents PCT/R/WG/4/13

facilitate the task of monitoring the respect of providing countries' ABS legislation and contracts. This proposal has been widely discussed and is the object of feasibility studies both in legal and practical terms.⁵⁴⁰ Thus far there is no international consensus on this measure, but the Bonn Guidelines and the conference of the parties invite patent applicants to disclose the origin of their genetic resources, and some countries have integrated or have considered integrating this requirement into their national legislation.⁵⁴¹ The second proposal originally argued that patent applicants should not only disclose the origin of genetic resources but also provide evidence of prior informed consent for their use.⁵⁴² This proposal goes one step further as it transfers the burden of proof to users. It is no longer the providing country that must monitor the use of genetic resources, and where appropriate demonstrate a breach of contract or ABS legislation, but users that must provide evidence they have fulfilled their obligations. Recently, the proposal has been amplified and several studies examine the possibility of establishing an international standardized system of certificates of origin to document and monitor genetic resource transfers.⁵⁴³ However, there is no clear understanding of how such a system could work, not to mention a

⁵⁴⁰ Nuno P. Carvahlo (2000) « Requiring Disclosure of Origin of Genetic Resources and Prior Informed Consent in Patent Applications Without Infringing the TRIPS Agreement/ The Problem and the Solution » 2 WASHINGTON UNIVERSITY JOURNAL OF LAW AND POLICY 371; WIPO (2004), *Technical Study on Disclosure Requirements Related to Genetic Resources and Traditional Knowledge*, document prepared by the Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore for the seventh meeting of the COP in Kuala Lumpur, Malaysia, from February 9 to 20, 2004, as document UNEP/CBD/COP/7/INF/17. The Technical Study is also available on the WIPO Website at <http://www.wipo.int/tk>

⁵⁴¹ **India** in the Section 10 (contents of specification) of the Patents Act 1970 as amended by the Patents Second Amendment Act (2002); **the Andean Communities**: in the article 26 of the Andean Decision 486; **Costa Rica** in the article 80 of the (Biodiversity) Law 7788; **Belgium** in the article 15 of the Patent Act 1984 as modified by the Patent Amendment Act on Biotechnological inventions 2005. See also Geertrui van Overwalle (2002), "Belgium Goes its Own Way on Biodiversity and Patents", 24 EUROPEAN INTELLECTUAL PROPERTY LAW REVIEW 33

⁵⁴² Brendan Tobin (1997), « Certificates of Origin: A Role for IPR Regimes in Securing Prior Informed Consent » in John Mugabe, et al (eds.) *Access to Genetic Resources: Strategies for Sharing Benefits*. Nairobi: ACTS Press.

⁵⁴³ Brendan Tobin, David Cunningham, and Kazuo Watanabe (2004), "The Feasibility, Practicality and Cost of a Certificate of Origin System for Genetic Resources. Preliminary Results of Comparative Analysis of Tracking Material in Biological Resources Centers and of Proposals for a Certification Scheme" Paper Submitted by the United Nations University to the Secretariat of the Convention on Biological Diversity for the Third Meeting of the Ad-Hoc Working Group on Access and Benefit Sharing Bangkok, 14-18 February UNEP/CBD/WG-ABS/3/INF/5

consensus on its prospects. Indeed, it is far from clear that the benefits of certificates of origin would outweigh the costs.

Those existing or considered changes might help reduce transaction costs and facilitate sustainable use of genetic resources; consequently, they may also have some positive impacts on biodiversity conservation. In 2002, the World Summit on Sustainable Development called for the negotiation of a legally binding international instrument on access and benefit sharing. The measures mentioned above are now at the center of the discussions in the CBD Ad Hoc Working Group on ABS.

However, after having analyzed legal changes induced by pharmaceutical bioprospecting activities, and current proposals to delve into that direction, I would like to come back to the agricultural sector where the property regime promoted by the CBD seems inadequate and where a different regime, moving in a rather opposite direction, has been developed.

5. The International Treaty on Plant Genetic Resources

In the previous chapter I described the access and benefit-sharing regime provided by the Convention on Biological Diversity (CBD). This regime relies on exclusive rights –patents and national sovereignty – and bilateral contracts. I also explained that more than a decade after its entry into force, this regime is nearly exclusively used for pharmaceutical research and has had limited success. In this chapter, I describe how the agricultural R&D community has created its own regime that fits into the legal framework set up by the CBD, though it completely modifies its logic. First, I observe two traits of the agricultural R&D community: the collective and cumulative dimension of innovation and the importance of social norms. Second, I explain the inadequacy of the CBD regime to rule such a community. Third, I recount the path towards the International Treaty on Plant Genetic Resources for Food and Agriculture. The last section is dedicated to the analysis of the Treaty in light of the different theoretical notions presented in this dissertation.

5.1 Characteristics of Agricultural R&D

The system of access and benefit sharing set up by the CBD that relies on exclusive rights and bilateral contracts, seems ill-adapted to the innovation process in the agricultural sector and conflicts with the still vivid sharing norms of scientists and breeders.

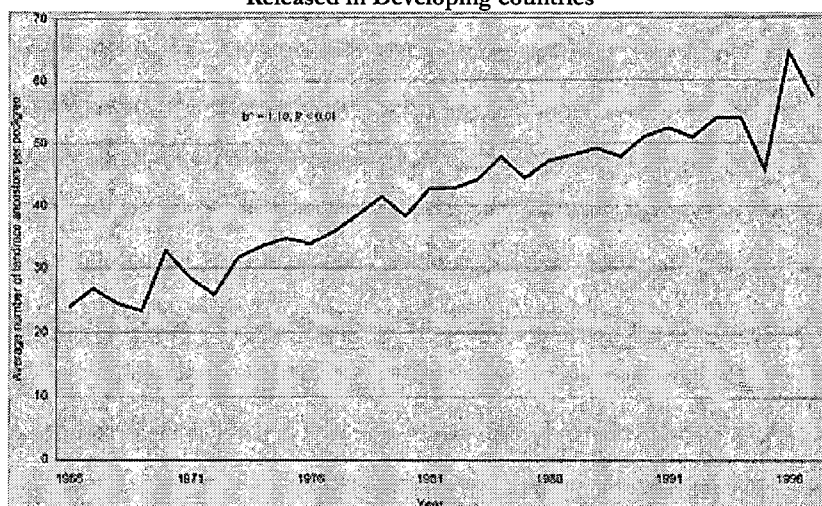
5.1.1 Innovation is Collective and Cumulative

Plant breeding is a collective and cumulative innovation process in two different senses. First, the innovation process is cumulative in the sense that today's varieties build on and interact with older varieties; it is collective in the sense that the creation of a new plant variety necessarily implies the combination of traits present in a large number of varieties. The creation of a new plant variety does not only imply the identification of an interesting compound in one plant but it also includes the identification of a large number of interesting traits among existing plants and their combination into a new variety. According to Marianne Banziger, maize plant breeder, plant breeding is *like collecting big stones from all over the world. You smash them together to make the small stones, and with that, you make a mosaic.*⁵⁴⁴ As an illustration, the genealogy of two recently

⁵⁴⁴ Daniel Charles (2001) "Seeds of Discontent", 294 SCIENCE 772

created maize varieties shows the collective dimension of plant breeding. The ancestors of those two varieties were landraces (traditional varieties) grown by farmers in Latin America. Some landraces had originally been collected by CYMMIT,⁵⁴⁵ some by Latin American research institutes and some by US scientists who placed them in a US seed bank. Some seeds found their way from the US to CYMMIT through Egypt and Kenya. To obtain two new varieties, Banziger spent ten years and crossed fifty breeding lines that she had chosen out of the several thousand in CYMMIT's collections.⁵⁴⁶ This example and those figures are quite illustrative of the plant breeding activity as shown by the next table.

**Numbers of Landraces Contained in Pedigrees of Wheats
Released in Developing countries**



Source: Smale *et al.* (2002)⁵⁴⁷

Second, plant breeding is a collective innovation process in the sense that there exists high interdependence between countries. All regions and

⁵⁴⁵ Center for the Improvement of Maize and Wheat, one the International Agricultural Research Centers that form the Consultative Group on Agricultural Research (CGIAR), see chapter 2

⁵⁴⁶ Daniel Charles (2001) "Seeds of Discontent", 294 SCIENCE 772, 26 October. The names of the two maize varieties are Grace and Zm521.

⁵⁴⁷ Smale *et al.* (2002), "Dimensions of Diversity in Modern Spring Bread Wheat in Developing Countries from 1965" 42 CROP SCIENCE 6 (November-December). For a more detailed study, country by country see also Ximena Flores Palacios (1998) "Contribution to the Estimation of Countries' Interdependence in the Era of Plant Genetic Resource", Background Study paper 7, FAO available at <http://ext-ftp.fao.org/ag/cgrfa/BSP/bsp7E.pdf>

countries are dependent on plant genetic resources from other regions or countries. Several studies observed that for the major food crops all regions are highly dependent on PGRFA from different regions.

Percentages of Regional Food Production Dependent Upon Crop Species Originating in Other Regions of Diversity

Regions	Percentage of dependence
Chino-Japanese	62
Indochinese	34
Australian	100
Hindustanean	49
West Central Asiatic	31
Mediterranean	99
African	88
Euro-Siberian	91
Latin-American	56
North American	100

Source: Kloppenburg & Kleinman (1987)⁵⁴⁸

Taking into account the specificities of their particular innovation process, plant breeders have developed formal and informal networks both locally and internationally, which embrace both the public and the private sector.⁵⁴⁹ At the international level, the Consultative Group on International Agricultural Research (CGIAR) network that links the International Agricultural Research Center (IARCs) and dozens of national agricultural research institutions (NARS) is an extensive exchange network for genetic resources and other research materials. Similarly, a series of regional networks have recently developed around the world. Finally, many breeders from different locations collaborate informally on a case-by-case basis when they have common interests or complementary skills and materials.⁵⁵⁰ At the national level, one can observe much cooperation between public and private research organizations. As for the local level, farmers involved in plant breeding have long traditions of seeds exchanges and collective innovation.

⁵⁴⁸ Jack R. Kloppenburg jr & DL Kleinman (1987), "Plant Germplasm Controversies- Analyzing empirically the Distribution of the World Plant Genetic Resources", 37 BIOSCIENCE 190-8

⁵⁴⁹ Ten Kate and Laird (1999), *The Commercial Use of Biodiversity (...)*, pp. 119 and 142

⁵⁵⁰ FAO (1996) *Rapport sur l'état des ressources phytogénétiques dans le monde*, chapter 6, table 6.1

5.1.2 Agricultural R&D and Social Norms

Those collaborative networks and the practice of research material exchanges are supported and ruled by social norms of shared-access and reciprocity. For a long time plant breeding has been ruled by a norm of shared-access relying on the conviction that one may not monopolize incremental contribution that increases collective knowledge. Once again, this norm of shared-access does not imply an absence of obligation; rather it creates a requirement for reciprocity. As observed by Ten Kate and Laird *for many years the ethos of plant breeding has been one of open access to plant genetic resources, and the common heritage of mankind as reflected in the text of the original International Undertaking. Researchers, breeders and even companies, traditionally obtained samples of germplasm from each other without paying and used them in their breeding programmes. The main benefit shared through the system was generally reciprocal access to other breeders' lines.*⁵⁵¹ These norms of shared access and reciprocity do not only apply to genetic resources but also to information on research results. As one private breeder explained: *It is an unwritten rule of ethics for breeders that when someone provides genetic resources, breeders will send them information relating to the research done.*⁵⁵²

As I described in Chapter two, plant breeders had succeeded in drafting a tailored legal regime, supporting shared-access for genetic resources and strengthening their social norms. On the one hand the Common Heritage doctrine has enabled open-access to *in situ* and *ex-situ* genetic resources and on the other hand the UPOV plant breeders' right has included a breeding exception that allows breeders to have access to each other varieties as research material. Plant breeders are much less satisfied with the regime established by the CBD, which is focused on the claims of developing countries and the pharmaceutical sector.

5.2 Inadequacy of the CBD Regime

Breeders perceive the CBD regime, which is entirely based on exclusive rights such as national sovereignty and patents, as being inadequate for their purposes. First, the regime is likely to drastically increase transaction costs. Second, there is a risk that the shared-access and

⁵⁵¹ Ten Kate and Laird (1999), *The Commercial Use of Biodiversity* (...), p.144; see also p. 145 & 148

⁵⁵² A private plant breeding company interviewed and quoted by Kerry Ten Kate and Sarah Laird (1999), *The Commercial Use of Biodiversity* (...), p. 148

reciprocity norms⁵⁵³ that play an important role in the coordination of genetic resource exchanges may become eroded.

5.2.1 A Problem of Transaction Costs

I have mentioned earlier that high transaction costs hinder the use of bilateral contracts to access genetic resources for pharmaceutical use. The presence of transaction costs is even more problematic in the plant-breeding sector because of the collective innovation process that strongly increases the number of transactions (recall that is quite common for a new variety to contain up to fifty other varieties in their pedigree). In addition, the historical interdependence between countries for PGRFA makes it difficult to use the notion of country of origin established in the CBD.⁵⁵⁴ Some observers mention the risk of anti-commons in agricultural R&D.⁵⁵⁵ Without going this far, a recent study⁵⁵⁶ attempted to assess the importance of transaction costs and their likely effect. In order to evaluate the importance of transaction costs generated by a bilateral system, one must compare transactions costs with the value of genetic resources to see whether they might prevent transactions from occurring. In addition, it is interesting to compare them with the transaction costs generated by an alternative system, i.e. a shared-access multilateral system. Transaction costs are likely to be lower under a multilateral system.⁵⁵⁷ A multilateral system can reduce **search costs** by

⁵⁵³ Hereafter, I use the expression norms of open access and reciprocity because members of the agricultural R&D community consider that GR are openly accessible to everybody. However, one must remember, as I mentioned at the end of chapter 2.2, that if genetic resources included in a protected variety are *de jure* in open access, they are often *de facto* the common property (shared access) of the agricultural R&D community

⁵⁵⁴ Gerald Moore & Witold Tymowski (2005): *Explanatory Guide to the International Treaty on Plant Genetic Resources for Food and Agriculture* IUCN Environmental Policy and Law Paper No. 57 (Gland, Switzerland and Cambridge, UK: IUCN). Available at www.iucn.org/themes/law/pdffdocuments/EPLP57EN.pdf, p. 3, note 11. Hereafter Gerald Moore & Witold Tymowski (2005): *Explanatory Guide to the International Treaty* (...)

⁵⁵⁵ Dwijen Rangnekar (2002), "Can TRIPs deter Innovation? The Anticommons and Public Goods in Agricultural Research", Paper for Conference Science and Citizenship in a Global Context: Challenges from New Technologies, Institute of Development Studies, University Of Sussex Brighton, UK, 12-13 December 2002

⁵⁵⁶ Bert Visser *et al.* (2000), "Transaction Costs of Germplasm Exchange Under Bilateral Agreements", Global Forum on Agriculture Doc No GFAR/00/17-04-04 available at

http://www.efar.org/documents/conference/GFAR_2000/gf170404.PDF

⁵⁵⁷ By comparison with bilateral contracts, a multilateral system may be useful to reduce transaction costs but this advantages must be balanced with maladaptation costs, i.e. the fact that a collective rule cannot adapt to specific characteristics of each bilateral exchanges as bilateral contract do.

maintaining a register of the existing genetic resources and their owners in order to facilitate the identification of users and providers as is done by copyright collective rights organizations. Regarding **bargaining costs**, a multilateral system can offer economies of scale in the design of rules: as there are many redundancies in contracts ruling exchanges of genetic resources (licenses), mandatory or optional standard contractual provisions allow parties to negotiate only a limited number of issues. A multilateral system can also include customized and responsive collective valuation mechanisms. Similarly, **monitoring and enforcement costs** might be reduced because access is free and there is no need to monitor the use of genetic resources or to sanction the violation of the agreements. A multilateral system may provide economies of scale if the monitoring and enforcement involve fixed costs that can be shared. It may also include alternative monitoring systems such as peer supervision and alternative dispute resolution mechanisms that are often more responsive and specialized than courts. Last, it may offer alternative (non legal) sanctioning mechanisms such as excluding those who do not fulfill their commitments from the multilateral system.

This recent study attempts to assess and compare the transaction costs generated under each system. According to this survey, the transaction costs range from \$900,000 to \$1.3 million for a multilateral system covering all non-industrial crops, and from \$16 million to \$48 million a year for bilateral agreements covering all crops (including industrial). There is thus an important reduction of transaction costs in the multilateral system. The same study compares the estimated transaction costs with the estimated expenditures of private sector breeders on the maintenance of genetic resources. R&D expenditures amount to approximately \$1 billion per year from which five percent or \$50 million are allocated to genetic resource maintenance. Therefore, it appears that in a comprehensive multilateral system, transaction costs are estimated at two to three percent of the total maintenance costs; whereas under the completely bilateral system, transactions costs are estimated at thirty-two to ninety-six percent of the maintenance costs. It is difficult to foresee the exact impact of those transaction costs on germplasm exchanges but the authors of the study conclude that excessively high transaction costs are entailed in a scenario in which all germplasm exchanges fall under bilateral agreements. To be precise, it should be added that the public sector is both the main users of genetic resources contained within genebanks and the main investor in genetic resource maintenance. The total public investment in conservation is estimated at \$922 million, this is almost twenty times the private sector investment. However, given that the objective of bilateral agreements is to capture part of the

benefits realized by the private sector, there is little sense in creating a system of bilateral agreements that will create transaction costs and offer no shared benefits.

5.2.2 A Risk of Erosion of the Norms of Shared-Access and Reciprocity

National sovereignty over genetic resources and the possibility to patent them favors a property regime; where access to any genetic resource requires the negotiation of a material transfer agreement, however, the adhesion to the norms of shared-access and reciprocity, facilitating exchanges of genetic resources, remains strong in the agricultural R&D community. Notwithstanding, the effectiveness of these norms is threatened and one can observe scientists and organizations departing from it. Indeed, the CBD regime, relying on exclusive rights, creates incentives that may run counter to these norms. The fear that another breeder could obtain a patent or plant breeders' right with one's genetic resources may render him reluctant to share his genetic resources to other breeders.

Even if public or private plant breeders believe strongly that the norm of shared-access ("cooperation" in game theory language) is the correct mode of behavior, they know that their colleagues may be tempted to ignore it because of the higher payoffs of restricting access. If plant breeders conclude that it is in their self-interest to limit access to their research tools ("defect" in game theory language or "free-ride" in the public good language), then they will expect their colleagues to do the same. The expectation that others will defect will lead even those who strongly adhere to the norm of open access to defect as well, since the worst position is to cooperate when others defect. In this scenario, a plant breeder would provide genetic resources for free while others would not. The plant breeder would have to pay royalties to all the others in order to access their findings while his own work would be totally uncompensated. Consequently, in game theory language, it can be said that the "equilibrium strategy" is likely to be to defect even if all the players would be better off where the cooperative behavior continued. In other words, the problem lies in the new reward structure created by the CBD; it is adverse to the enforcement of the norms of shared-access. In addition, the risk of **internal defection** (appropriation by members of the agricultural R&D community) is strengthened by **external defection**. External defection is where third parties that are not submitted to the norms, e.g., firms working in other sectors, decide to

patent genetic resources thus making them unavailable for members of the community.

Plant breeders were aware of the inadequacy of a regime based on exclusive rights over their innovation processes and they understood the potential conflict between this regime and the social norms ruling their activities. Within the framework settled by the CBD, plant breeders have thus progressively built a sub-regime that better suits their activities. In the previous chapter I mentioned a 1991 modification of the UPOV Convention. This modification introduced the notion of “essentially derived variety” and attempted to introduce a balance between traditional breeders who resort to plant breeder’s rights and biotech companies who resort to patents⁵⁵⁸. The snapshot of this modification is, however, a renewed attack against genetic resource open access. This time, within the Food and Agriculture Organization (FAO), plant breeders succeeded in using exclusive rights to recreate a system of limited open-access or shared-access.

5.3 The Way towards the Treaty

There were two triggers to new negotiations within the FAO. First, the CBD, a framework convention, covers all types of genetic resources. The CBD’s entry into force did not abrogate the FAO International Undertaking, which focuses on plant genetic resources for food and agriculture (PGRFA), though it was required that its revision be in harmony with the CBD. Second, the CBD provisions do not apply retroactively. Therefore, the CBD provisions on access and benefit sharing do not apply to *ex-situ* collections of genetic resources constituted before the CBD entered into force⁵⁵⁹.

The need to (1) adapt the International Undertaking and (2) to rule access to *ex-situ* collections created prior to the CBD is recognized in resolutions adopted by both the CBD’s organs and the FAO. The final Act of Nairobi, which closed the negotiations of the CBD in May 1992, includes a Resolution that *recognizes the need to seek solutions to outstanding matters concerning plant genetic resources within the Global System for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Sustainable Agriculture, in particular: (a) Access to ex-situ collections not acquired in*

⁵⁵⁸ Actually some firms resort to both traditional breeding and transgenesis and this might be increasingly the case with the growing concentration of the sector.

⁵⁵⁹ It is explicitly stated in article 15 §3

*accordance with this Convention; and (b) The question of farmers' rights*⁵⁶⁰. In 1993 the FAO Conference adopted a similar resolution that called for the revision of the International Undertaking and *requested FAO to provide a forum in the CGRFA, for the negotiation among governments, for (a) the adaptation of the International Undertaking on Plant Genetic Resources, in harmony with the CBD; (b) consideration of the issue of access on mutually agreed terms to plant genetic resources, including ex situ collections not addressed by the CBD; and (c) the issue of the realization of Farmers' Rights.*⁵⁶¹

The first FAO achievement consists in the adoption in November 1993 of an International Code of Conduct for Plant Germplasm Collecting and Transfer. There is little to say about this code of conduct. Adopted just after the Rio Convention, it sticks with the text of the CBD and diverges from the International Undertaking. The primary function of this voluntary code of conduct is to serve as a point of reference until such time as individual countries establish their own ABS regulations. Although it contains useful guidelines for countries considering the adoption of ABS regulations, the code draws little attention.⁵⁶²

The revisions of the International Undertaking and its transformation into a legally binding International Treaty on Plant Genetic Resources for Food and Agriculture took eight years. Before describing the content of this Treaty, it is worth mentioning a series of changes that took place in the margins of the negotiations, yet prepared the content of the Treaty. This enables us to see how both a community of public researchers working for the International Agricultural Research Centers (IARCs) and plant breeders progressively managed to draft a legal regime that is well suited to their activities and is mutually supportive of their social norms of shared-access and reciprocity.

The CBD left open an urgent question: **the legal status of the genetic resources collection held by IARCs and coordinated by the CGIAR and IPGRI**. Indeed, the CBD does not apply to pre-existing *ex-situ* collections. Moreover, national sovereignty could not apply to these

⁵⁶⁰ Resolution 3 of the Nairobi Conference for the Adoption of the Agreed Text of the Convention on Biological Diversity, "The Interrelationship between the Convention on Biological Diversity and the Promotion of Sustainable Agriculture". The text of the Resolution is available at <ftp://ext-ftp.fao.org/ag/cgrfa/Res/CBD3E.pdf>

⁵⁶¹ Resolution 7/93, "Revision of the International Undertaking on Plant Genetic Resources", Twenty-seventh Session of the FAO Conference Rome, 1993. The text of the Resolution is available at <ftp://ext-ftp.fao.org/ag/cgrfa/Res/C7-93E.pdf>

⁵⁶² Marie-Angèle Hermitte (2004), "La construction du droit des ressources génétiques...", p. 78

collections because, even if they are located in host countries, the international community has always funded them and furthermore, they hold genetic resources collected from a multitude of countries. To answer this question, the IARCs resorted to the legal technique of bilateral contracts between each IARC that held an *ex-situ* collection and the FAO. All bilateral contracts are the same and a joint statement signed by all the IARCs to clarify the content of the bilateral contracts completes them.⁵⁶³ Regarding the content of the agreement, the CGIAR centers placed their collection under the auspices of the FAO; these collections must be part of an international network of *ex-situ* collections already claimed by the 1983 International Undertaking. The CGIAR centers consider themselves to be the trustee of those collections for the benefit of the international community. Therefore, CGIAR centers agreed to make their collections freely available.

While further describing the contents of the agreement, I employ some of the theories presented in Part I. I first examine the effect of the Agreement on transaction costs. Second, I look at how it affects the property regime of genetic resources. Third, I observe that the Agreement is a formalization of social norms in place among the agricultural R&D community.

Transaction costs are not the main rationale behind the Agreement. The Agreement does not deal with access to or exchange of genetic resources but rather consists of a collective commitment of large holders of genetic resources to place them in open-access. Nevertheless, placing genetic resources in open-access minimizes transaction costs, because it suppresses the need for owners and users to find each other (search costs) in order to negotiate MTA's (bargaining costs), monitor each other, and enforce MTA provisions in the case of violation (monitoring and enforcement costs).

The heart of the Agreement is the safeguarding of shared access and reciprocity **social norms**. The Agreement insists on the continuity with past policies and social norms. The preamble of the agreement includes

⁵⁶³ Agreement Between [name of center] and the Food and Agriculture Organization of the United Nations (FAO) Placing Collections of Plant Germplasm under the Auspices of the FAO (1994) and Joint Statement of FAO and CGIAR Centers on the Agreement Placing CGIAR Germplasm Collection under the Auspices of the FAO (1994). Both documents have been published in the Booklet of CGIAR Centers *Policy Instruments, Guidelines and Statements on Genetic Resources, Biotechnology and Intellectual Property Rights*, Version II, SGRP, Rome 2003. The Booklet is available at <http://singer.cgiar.org/booklet.pdf>

recitals considering that *the CGIAR adheres to a policy on plant genetic resources which is based on the unrestricted availability of Germplasm held in their genebanks and considering that the Germplasm have been donated [to the centers] or collected [by the centers] on the understanding that these accessions will remain freely available and that they will be conserved and used in research on behalf of the international community, in particular the developing countries.* It is worth examining how this Agreement preserves social norms by slightly modifying their provisions (property regime) and formalizing them through a combination of contract and property rights so as to be able to enforce them against internal or external defection.

Regarding their **property regime**, genetic resources are in open access (or *res publicae*). However, this property regime is not simply the public domain. In a simple public domain, pieces of knowledge are available only because they are not IPR protected and anyone can take and use whatever they wish and can subsequently mix the knowledge with new pieces of knowledge and qualify for IPR protections. By contrast, in the property regime created by the Agreement, genetic resources are available only for the purposes of scientific research, plant breeding and/or conservation; open access is not guaranteed for other uses. In addition, access is not unconditional; there are two conditions to accessing this regime : (1) there is an obligation not to claim any IPRs and (2) there is an obligation to include a similar condition in subsequent transfers. The recipient must agree *not to claim ownership over the material, nor to seek IPRs over that material or its genetic parts or components, in the form received.* The recipient must further agree *to ensure that any subsequent person or institution to whom he/she may make the samples of the material available, is bound by the same provisions and undertakes to pass on the same obligations to future recipients of the material.*⁵⁶⁴ These types of provisions are sometimes called “copyleft” or “share alike” because they only allow the recipient to distribute copies of the material or derivatives under a license identical to the license that governs the first transfer. Such provisions are also said to have a “viral effect” because the terms of the license allowing the recipient to use the protected content must be included in any subsequent transfer. Therefore, anyone wanting to develop an invention/work including a piece of content protected by such a license is required to make it available under the same conditions⁵⁶⁵. However, a

⁵⁶⁴ The text of the standard Material Transfer Agreement is available in the same booklet.

⁵⁶⁵ When the terms of the license prohibits claiming property rights Chander and Sunder suggest that this can be analyzed as an example of the third type of rules identify by Calabresi and Meland, i.e. Inalienability. However in this case the protected content does not inalienably belongs to someone rather it is inalienably in open-access,

very important issue in measuring the extent of the viral effect is to determine the degree to which it is applied to derivation. In the case of genetic resources held by CGIAR centers, it seems that the viral effect does not extend to a high degree of derivation. This is because the Material Transfer Agreement provides that *the recipient, therefore, hereby agrees not to claim ownership over the material, nor to seek IPRs over that material, or its genetic parts of components, in the forms received.* The recipient also agrees not to seek IPRs over related information received.⁵⁶⁶ However, the exact meaning of the expression “in the form received” is not perfectly clear. The same expression was introduced in 2001 in the International Treaty on Plant Genetic Resources for Food and Agriculture (the “International Treaty”) and elicited unsettled sharp controversies on the exact meaning of the expression (*Cf. infra*).

Beyond its content, this agreement is an interesting attempt to “**formalize social norms**”, i.e. insert their provision into contracts. Indeed, genetic resources are in open access not because they are unprotected by IPRs or because they cannot be protected by IPRS. Rather, genetic resources are in open access because of the will of the centers and through contractual mechanisms: users can obtain genetic resources for free but they have to sign a standard Material Transfer Agreement by which they commit to stick to the norm of open access. There are some similarities between this agreement and the attempt of American scientists to formalize their norms that I examined in Part I. Similarities are even greater with open-source mechanisms first developed in the software sector and then extended to other sectors through initiatives such as Creative Commons⁵⁶⁷. The open-source community faced the same two threats as were faced by the agricultural R&D community: the vulnerability of their norms-based regime to both internal and external defection. One of the adopted solutions has been to obtain formal intellectual property rights that allow third parties to use, modify and redistribute the knowledge, as long as they respect the norms of the community embodied in the text of the license. If a user violates the norms, he can be sued either for breach of the license or for infringement of the IPRs (copyright).

In this Agreement, MTAs play exactly the same role as licenses in the various open-source initiatives and in the different collective rights

it cannot be appropriated. See Anupam Chander and Madhavi Sunder (2004), “The Romance of the Public Domain”, 92 CALIFORNIA LAW REVIEW 5 at 1333

⁵⁶⁶ My emphasis

⁵⁶⁷ For a presentation of the Creative Commons initiative see www.creativecommons.org

organizations. As to the role of formal property rights, the situation for genetic resources held by CGIAR centers, are similar but slightly different. CGIAR centers can include open-access conditions in MTAs because they have some rights to the transferred genetic resources. However, the nature of their rights is not perfectly clear. The agreement between the centers and the FAO provides that the centers *shall not claim legal ownership over the designated Germplasm, nor shall [they] seek any intellectual property rights over the Germplasm or related information*, rather the centers regard themselves as trustees of their genetic resources. There are therefore two possible understandings of the rights of the centers. Under the first interpretation, it could be argued that the CGIAR centers can impose conditions on recipients because they are in possession of material including genetic resources. In that case, recipients must accept the center's terms and conditions requiring access to genetic resources. This interpretation has two consequences. First, though it provides centers with a contractual right against the recipient it does not give them the right to take direct action against a subsequent recipient who does not respect the condition of open-access. This is different from the open-source case where the author is protected by copyright, i.e. his right is *erga omnes*; he can invoke his right against any subsequent recipient. Second, if a center's rights are limited to possession of their collection, it means that someone can access identical genetic resources from a different provider and possibly claim intellectual property rights on material including these genetic resources. Under the second interpretation, one could argue that centers could invoke trustee rights against subsequent recipients who fail to respect the open-access condition. However, it is far from clear whether a trustee who holds plants or seeds containing genetic resources, is enabled to take a direct action against a subsequent recipient who claims IPRs in genetic resources. Only an IPR that follows genetic resources (knowledge content of the plant or seeds sample) can enable direct action.

The Agreement between the CGIAR centers and the FAO and their Joint Statement *represent but one stage of a continuing, dynamic process*⁵⁶⁸ in implementing and adapting the CBD regime to the characteristics of the agricultural sector. Among **the next intermediary stages** before the adoption of the International Treaty, the adoption in 1998 of a Second Joint Statement of FAO and the CGIAR Centres on the Agreement

⁵⁶⁸ Joint Statement of FAO and CGIAR Centers on the Agreement Placing CGIAR Germplasm Collection under the Auspices of the FAO (1994), paragraph 6.

Placing CGIAR Germplasm Collections under the Auspices of FAO⁵⁶⁹ is worthy of mention. This Second Joint Statement includes some provisions regarding monitoring and enforcement of the terms of the material transfer agreement. Under the Statement, CGIAR centers and FAO agree to share responsibilities to monitor compliance with the provisions of MTA and to take legal action against possible infringers. In 1999, CGIAR centers also adopted the Guidelines for Germplasm Acquisition Agreements in which the centers committed to respect the access conditions set out in the CBD. The centers also claimed that they would *attempt to acquire Germplasm without conditions which would restrict future availability*. In other words, centers want to apply their open-access policies not only to genetic resources collected before the entry into force of the CBD but also to newly acquired genetic resources. Therefore, they attempt to negotiate access conditions with providing countries that allow them to do so. In 2000, with the adoption of a standard Material Transfer Agreement and Guidelines for the Acquisition and transfer of these types of genetic resources, the policy of open-access was then extended to non-plant genetic materials such as Micro-Organisms, Animals and Aquatic and Marine Material.

5.4 The International Treaty

The Agreement between the CGIAR centers and the FAO and their Joint Statement was a first step in a larger process. The main achievement of the agricultural community consisted of the negotiation of the International Treaty on Plant Genetic Resources for Food and Agriculture⁵⁷⁰ (the “International Treaty”). The agreement and the Joint Statement concerned only a dozen of genetic resources holders –the largest however –deciding unilaterally to place them in open-access providing recipients do not claim property rights on the receive resources. This time, the issue was the negotiation of a legally binding international treaty where a large number of countries were acting simultaneously as users and providers to negotiate reciprocal access to each other’s resources.

⁵⁶⁹ The Second Joint Statement has also been published in the Booklet of CGIAR Centre Policy Instruments, Guidelines and Statements on Genetic Resources, Biotechnology and Intellectual Property Rights, Version II, SGRP, Rome 2003. The Booklet is available at <http://singer.cgiar.org/booklet.pdf>

⁵⁷⁰ International Treaty on Plant Genetic Resources for Food and Agriculture, opened for signature 3 November 2001, entered into force 29 June 2004. The official text is available at <http://www.fap.org/ag/cgrfa/IU.htm>

Regarding its connection with the CBD, the International Treaty creates a complementary regime and a sub-regime. It creates a complementary regime in the sense that it rules over *ex-situ* collections of genetic resources that are not regulated by the CBD. It is also a sub-regime in the sense that it fits within the legal framework established by the CBD and provides a detailed regime for a specific component of biodiversity, and certain plant genetic resources for food and agriculture listed in Annex I of the Treaty⁵⁷¹. If the general goal of Treaty is the attainment of food security⁵⁷², its objectives are those of the CBD: the conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use⁵⁷³. However, although the International Treaty fits into the legal framework settled by the CBD, it creates a regime of access to genetic resources and benefit sharing (ABS) with a very different logic.

The Treaty contains detailed provisions for the conservation and the sustainable use of genetic resources. The centerpiece of the treaty, however, is its “**multilateral system for access and benefit sharing**”. While I further describe the content of the Agreement and its multilateral system, I will refer to some of the theoretical elements presented in Part I.

In Part I, I first mentioned the possibility of protecting an entitlement with a liability rule rather than a property rule. Liability rules suppress the need to obtain the consent of the holder while including a mechanism for collective valuation. In so doing, in some circumstances liability rules can reduce bargaining costs. Secondly, I observed that economic agents may modify their entitlements by contract and may possibly create collective rights organizations (CROs). CRO's and liability rules complete each other; collective rights organizations can include contractually created liability rules⁵⁷⁴ or they can manage liability rules created by the government⁵⁷⁵. Regarding transaction costs, collective rights organizations can help reduce search costs, bargaining costs, monitoring and enforcement costs. Thirdly, I noticed that in terms of property regimes, liability rules and collective rights organizations could create intermediary situations between the two extremes, i.e. exclusive rights and the public domain. Finally, I examined whether these CROs

⁵⁷¹ The treaty makes no distinction between genetic resources held before the entry into force of the CBD and the material acquired after.

⁵⁷² Article 1

⁵⁷³ Article 1

⁵⁷⁴ What Robert P. Merges calls “contracting into liability rule” see Robert P. Merges (1996), “Contracting into Liability Rules...”, at 1293

⁵⁷⁵ Like the Copyright Societies that manage statutory licenses on behalf of authors.

fulfilled the conditions of resilience (the institutional design principles) identified by Ostrom. I will now examine the International Treaty in light of these elements.

5.4.1 Transaction Costs: Liability Rules and Collective Rights Organizations

The International Treaty can be analyzed in light of a situation where rights holders modify their entitlements by contract and create a collective rights organization in order to reduce transaction costs. The case of the International Treaty is a bit particular because it does not deal with economic agents, contracts and a single government but rather with sovereign states and treaties in the absence of an international government. However, except for the absence of an international government that can create or modify entitlements, the process is not very different. Consistent with the legal framework created by the CBD, the contracting parties recognize their mutual sovereign rights over their respective genetic resources but they use those sovereign rights to create a multilateral system to facilitate access. In other words, they contractually create a collective rights organization to reduce transaction costs. Article 10.2 provides that *in the exercise of their sovereign rights, the Contracting Parties agree to establish a multilateral system, which is efficient, effective, and transparent, both to facilitate access to plant genetic resources for food and agriculture, and to share, in a fair and equitable way, the benefits arising from the utilization of these resources, on a complementary and mutually reinforcing basis.*⁵⁷⁶

The multilateral system attempts to facilitate access by reducing different kinds of transaction costs.

The multilateral system is useful in reducing search costs. In order to facilitate the identification of an exchange partner, the participating states agree to create an information system⁵⁷⁷ that encompasses catalogues, inventories, and information including characterization, evaluation, and utilization of their genetic resources⁵⁷⁸. Moreover, the multilateral system suppresses the need to identify the country of origin, which according to the CBD is the only country that can give its prior informed consent to access its genetic resources⁵⁷⁹. However, it must also be said that the

⁵⁷⁶ The penultimate recital of the Preamble contains a similar provision

⁵⁷⁷ Article 17

⁵⁷⁸ Article 13.2 (a)

⁵⁷⁹ Article 15 of the CBD dealing with access to genetic resources does not apply to *ex-situ* collections acquired before its entry into force but it applies to *ex-situ* collections acquired after. In the Treaty, the contracting parties use their national sovereignty to

reduction of search costs is mainly due to the nature of *ex-situ* collections of genetic resources where resources are classified and documented in contrast to *in-situ* genetic resources that are obviously not classified and sometimes even unknown.

As for the **cost of monitoring** the behavior of the parties and the **cost of enforcing** the agreement, they only occur when an agreement takes time to fulfill. The multilateral system can lower monitoring costs in two ways: either by suppressing the need to monitor the parties or by creating a centralized and cheaper way to monitor them. The first question is thus to identify what behaviors must be monitored. The Treaty contains a provision stating that *access shall be accorded [...] without the need to track individual accessions [...]*⁵⁸⁰. However, this provision must be carefully interpreted. To a certain extent, the use of material transfer agreements implies that individual transfers are automatically registered. Moreover, access is not provided without conditions. The two main obligations of genetic resources recipients are: first, not to claim any IPRs or others rights on the received genetic resources where they could limit the facilitated access⁵⁸¹, and second, in case of commercialization of a product incorporating the received genetic resources, the recipient must either allow access to the product for research and breeding purposes or pay compensation to the multilateral system⁵⁸². Therefore, providers will not need to track or monitor all subsequent transfers of the provided genetic resources. Tracking the provenance of genetic resources accessed from the multilateral system will only occur when the recipient or any subsequent recipient claims rights to the material received or where they develop a product incorporating the resources accessed⁵⁸³. The second question regards knowing whether the multilateral system includes a mechanism that lowers monitoring and enforcement costs. The Treaty contains few elements on this issue.

agree to create a multilateral system and suppress the need to identify the country of origin and the obligation to obtain his consent.

⁵⁸⁰ Article 12.3 (a)

⁵⁸¹ Article 12.3(d); provides that “*recipients shall not claim any intellectual property or other rights that limits the facilitated access to the plant genetic resources for food and agriculture, or their genetic part or components, in the form received from the multilateral system*.” There remains uncertainty and disagreement on the exact meaning of the expression “in the form received”. And the degree of change beyond which genetic resources are no longer «in the form received» and therefore are no longer subjected to the obligations defined in the treaty. This lack of clarity has caused a series of developed to stress their understanding of that provision, and Japan preferred postponing its signature of the treaty.

⁵⁸² Article 13.2 (d) (ii)

⁵⁸³ Gerald Moore & Witold Tymowski (2005), *Explanatory Guide to the International Treaty* (...), p. 104

However, article 21 requires the governing body to set up effective procedures and operational mechanisms to monitor compliance and sanction non-compliance.⁵⁸⁴

Above all, the multilateral system includes several elements capable of reducing **bargaining costs**, i.e. the cost of reaching an agreement between the provider and the recipient. The multilateral system replaces bilateral (market) valuation by a mechanism of collective valuation more efficient in situations of information asymmetries (information about the threat values and the bargaining surplus is private) and suppresses the need to obtain the consent of the provider. In other words it creates a kind of **liability rule**. In addition, the multilateral system offers economies of scale in the design of rules: as there are many redundancies in contracts ruling exchanges of property rights (licenses), standard contractual provisions allow parties to negotiate only a limited number of issues such as the type and the quantity of genetic resources.

The multilateral systems determine the conditions of access and the forms of **benefit sharing** as follows: parties agree to provide access for free⁵⁸⁵ but not without conditions. First, access must be reciprocal (*Cf. infra*), the recipient may not claim any IPRs⁵⁸⁶ to genetic resources in the form received, and he must leave the resources available to the multilateral system.⁵⁸⁷ Therefore, as noted in article 13, a major benefit of the multilateral system consists in accessing a large range of genetic resources. In a situation of high interdependence on each other's genetic resources (*Cf. sub-section 5.1.1*), all participating countries are winners because they all receive access to more genetic resources than they contribute. Second, the recipients must funnel back part of the benefits derived from the use of received genetic resources when the following circumstances are present: (1) the recipient develops a product derived from the received genetic resources, (2), this derived product is itself a plant genetic resource for food and agriculture⁵⁸⁸, (3) it commercializes it

⁵⁸⁴ The first draft of the Standard Material Transfer Agreement provides that the Governing Body has the right to monitor the execution of this MTA and to initiate dispute resolution procedure (article 5.2) and that the obtains an IPR on material received, he must mention it to the governing body (article 7.4)

⁵⁸⁵ Article 12.3 (b). Actually providers may charge a minimal administrative fee but it should not exceed the cost involved or constitute a hidden access fee.

⁵⁸⁶ Article 12.3 (d)

⁵⁸⁷ Article 12.3 (g). To be precise, article 12.3(a) contains an additional condition: recipients may only use the received resources for agricultural purposes (*Cf. infra*)

⁵⁸⁸ This requirement does not apply to the commercialization of a product that is not itself plant genetic resources for food and agriculture. For instance, it would not apply to pasta containing wheat produced by a new variety created by incorporating material

and (4) the product is otherwise unavailable without restriction to others for research and breeding. If the product is available without restriction for research and breeding (either because it is not protected or it is protected by UPOV plant breeders rights or by a patent in a country where patent law provides a large research exception), the payment is voluntary. However, the governing body may decide to make this payment compulsory in both situations⁵⁸⁹.

Like other collective rights organizations examined in part one, the multilateral system not only fixes the level of the contribution (collective valuation) but it also collects the fund, manages them and organizes the distribution among providers. The precise conditions in which the recipient may have to funnel back part of their benefits and the level of his contribution will be determined in a standard MTA to be negotiated by the governing body⁵⁹⁰. As for the collection, management, and distribution of funds, the Treaty asks the governing body to establish a mechanism such as a trust account⁵⁹¹. To be complete, the Treaty also mentions other forms of benefits sharing such as exchange of information, access to and transfer of technology and capacity building, though they are not directly related to access to genetic resources⁵⁹².

In addition, even if they are not strictly speaking transaction costs, it is worth mentioning that joining the multilateral system does not burden participating countries with high **implementation or administrative costs**. They only need to recognize the provisions of the Treaty in their domestic law. Contrary to the CBD, there is no need to draft new legislation and to create institutions to implement it.

obtained from the multilateral system). For more detail see Gerald Moore & Witold Tymowski (2005): *Explanatory Guide to the International Treaty* (...), p. 110

⁵⁸⁹ Article 13.2 (d) (ii). The first draft of the standard MTA (see next footnote) keeps the two options (voluntary or compulsory payment) opens (article 7.10 and 10.4).

⁵⁹⁰ Article 13.2 (d) (ii) and 12.4. A Contact Group for the Drafting of the Standard Material Transfer Agreement has been set up. Hereafter, I make some references to the first draft of the standard MTA but only in the footnotes because it is still very far from an approved standard MTA. See Report of the Contact Group for the Drafting of the Standard Material Transfer Agreement Hammamet, Tunisia, 18-22 July 2005, available at <ftp://ext-ftp.fao.org/ag/cgrfa/cgmta1/smta1repe.pdf>

⁵⁹¹ Article 19.3(f)

⁵⁹² The first draft of the standard MTA does not provide more precision on the sharing of non-monetary benefit (article 7.12) except that it envisages as a possible option the obligation to deposit in the multilateral system a sample of a plant genetic resources developed by recipient from resources from the system (article 7.11, option 1)

5.4.2 Property Regime: a Limited Commons?

After having regarded the International Treaty as a combination of liability rules and collective rights organizations used to reduce transaction costs and facilitate exchanges of genetic resources, it is also interesting to examine the Treaty in terms of property regimes and observe whether it creates **intermediary situations** between the two extremes of exclusive individual rights and the public domain. It is not possible to give a perfectly definitive answer because some provisions of the Treaty are unclear and the contracting parties do not fully agree on their meaning. Moreover, the Treaty leaves some options open to be decided by the governing body.

Having acknowledged this imprecision, I argue that the multilateral system creates a **limited commons**⁵⁹³ including some characteristics of the **public domain** as well as some characteristics of **the open-content+ copyleft**. A limited commons is defined by Carol Rose as “property held as commons amongst the member of a group, but exclusively vis-à-vis the outside world”⁵⁹⁴. The notion of limited commons is similar to the notions of shared access, *res universitatis* or common property I presented in Part I. The four notions share the same characteristics: a group within which access is shared, but access is not granted to those that do not provide access to their genetic resources. The group includes those who contribute, but excludes free-riders. In the IPR context, the notion of limited commons acknowledges the usefulness of property rights in intellectual achievement, but unlike individual IPRs, they focus first on encouraging the group interactions that foster creativity, and second, on policing the boundaries of behaviors that are disruptive to the creative group.⁵⁹⁵

In order to describe a limited commons, I must identify the following elements: the resources placed in the commons, the members or the contributors, the internal access regime and the external access regime which establish a connection between the contribution to the limited commons and the conditions for accessing the limited commons .

⁵⁹³ For a similar argument see Laurence R. Helfer (2005) “Using Intellectual Property Rights to Preserve the Global Genetic Commons: The International Treaty on Plant Genetic Resources for Food and Agriculture” in Keith Maskus and Jerome H. Reichman (eds.) *International Public Goods and Transfer of Technology Under a Globalized Intellectual Property Regime*, Cambridge University Press

⁵⁹⁴ Carol M. Rose (1998), “The Several Futures of Property: Of Cyberspace and Folk Tales, Emission Trades and Ecosystems, 83 MINNESOTA LAW REVIEW 129, p. 132

⁵⁹⁵ *Ibidem*

As for the resources placed in the commons, the Treaty is clear. The Multilateral system only concerns a limited number of plant genetic resources for food and agriculture listed in Annex I. These resources however are probably the most valuable.

Regarding the identification of the members, the description is slightly more complicated. An international treaty creates the multilateral system; therefore, the analysis must be done at the level of states as contracting parties, and at the level of public or private organizations holding genetic resources.

At the level of states, article 10 of the Treaty distinguishes between relations among contracting parties and relations between contracting parties and other states. Relations among members are ruled by the multilateral system described above. Relations with non-members are ruled by the CBD. There is no common external regime; users of genetic resources must negotiate access with each state individually.

At the level of organizations providing or accessing genetic resources the Multilateral System establishes two connections between the degree of contributions to the limited commons and the conditions of access.

The first contribution such an organization can make consists of providing other members with facilitated access to its collection. In exchange, it will receive reciprocal access to other members' collections. Genetic resources held by public sector organizations are included in the system and those organizations have access to genetic resources held by other participating institutions⁵⁹⁶. CGIAR centers are also included in the Multilateral System⁵⁹⁷. Regarding private organizations holding plant genetic resources⁵⁹⁸, they are encouraged to include them in the Multilateral System while the governing body must decide whether organizations refusing to include their genetic resources can benefit from the Multilateral System⁵⁹⁹. This last provision is essential to determine the nature of the property regime created by the International Treaty. If some organizations can benefit from the Multilateral System, whether or not they include their collection, the treaty looks like an agreement by which some genetic resource holders agree to place them in open-access

⁵⁹⁶ Article 11.2; to be precise the treaty mentions genetic resources that are under the management and control of the contracting parties and in the public domain.

⁵⁹⁷ Article 11.5

⁵⁹⁸ Article 11.3; to be precise the treaty mentions natural and legal persons under [the contracting parties'] jurisdiction.

⁵⁹⁹ Article 11.4

(or the public domain) just like the CGIAR centers in the agreement mentioned before. In contrast, if facilitated access is only provided to organizations that include their resources in the system, i.e. implying a rule of reciprocity, then the treaty is really creating a limited commons. The same article 11.4 also considers the possibility of *other measures as [the governing body] deems appropriate*. Using this provision, the governing body could draw a common external regime for non-participating organizations wanting to access genetic resources included in the Multilateral System.

The second contribution consists in extending the limited commons by including products derived from genetic resources accessed from the Multilateral System. This is why, access is solely provided for agricultural uses and chemical and pharmaceutical uses are explicitly excluded. The rationale of this exclusion lies in the fact that the pharmaceutical sector has a long tradition of patenting and relying on exclusive property rights running counter the idea of shared-access. Access to genetic resources for chemical and pharmaceutical uses is ruled by the CBD. There is no common external regime; pharmaceutical companies must negotiate bilateral contracts with each state individually.⁶⁰⁰ As for the agricultural sector, the treaty offers a choice to the recipient that uses the received genetic resources to develop and commercialize a product that is a plant genetic resources: either he makes the products available without restriction for further research or plant breeding or he pays a share of the benefits to the multilateral system. Thus, if recipients contribute to enlarge the limited commons by including the new product, access is free, if not they have to contribute by paying a share of their benefits.⁶⁰¹

Finally, the multilateral system is not only a limited commons; it also includes some traits of open-content + copyleft. First, a recipient may not *claim IPRs or other rights that limit the facilitated access to the plant genetic resources for food and agriculture, or their genetic parts or components in the form received*⁶⁰². Second, a recipient must require that the conditions of access defined in the Treaty and the standard MTA apply to any subsequent transfers to third parties.⁶⁰³

⁶⁰⁰ In addition, Biodiverse countries were reluctant to abandon the bilateral mechanisms for pharmaceutical uses as they still expect important benefits from it.

⁶⁰¹ Article 13.2(d) (ii)

⁶⁰² Article 12.3(d)

⁶⁰³ Article 12.4. The first draft of the standard MTA provides that these subsequent transfers must be accompanied by the signature of a new standard MTA (article 7.7) and it adds that if a recipient who obtain a restrictive IPRs on material received and transfers that IPR, he must transfer the benefit-sharing obligations (article 7.13)

I must add an additional remark on Farmer's Rights. The International Treaty dedicates one article to Farmer's Rights, though these rights remain a political concept without any real legal implications. One can observe a growing separation between the notion of Farmer's Rights and the issue of benefits sharing. Actually, this separation was already present but went unnoticed in the FAO Resolutions 4/89 and 5/89 (*See Part II, chapter 3*). The principal change lies in the Treaty negotiator's disregard of the issue and effective transfer of the responsibility to formulate Farmer's Rights to national governments. For the remainder, article 9 of the Treaty only repeats provisions of Resolutions 4/89 and 5/89 and article 8J of the CBD. Farmer's Rights appear to be a kind of broad political concept encompassing different issues discussed in others places: protection of traditional knowledge, farmers' privilege, and the right to participate in the political process.

5.4.3 Institutional Design

After examining how the Multilateral System creates a limited commons and attempts to reduce transaction costs, it might be worthwhile to examine it in the light of the design principles identified by Elinor Ostrom, i.e. essential elements or conditions that help to account for the success of these institutions in sustaining the limited commons and gaining enduring compliance to the rules in use.

(a) Clearly defined boundaries (resources and members)

Resources included in the limited commons as well as individuals who have rights to access resources must be clearly defined.

(b) Congruence between appropriation and provision rules and local conditions

(c) Collective choice arrangements

Most individuals affected by the operational rules can participate in modifying the operational rules

(d) Monitoring

Monitors, who actively audit conditions of the resources placed in the limited commons and appropriators' behavior, are accountable to the appropriators or are the appropriators

(e) Graduated sanctions

Appropriators who violate operational rules are likely to be assessed graduated sanctions by other appropriators, by officials accountable to these appropriators, or by both.

(f) Conflict-resolution mechanisms

Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials.

(g) Minimal recognition of right to organize

The rights of appropriators to devise their own institutions are not challenged by external governmental authorities.

For CPRs/limited commons that are parts of larger systems

(h) Nested enterprises

Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Clearly, the International Treaty pays a lot of attention to the definition of the limited commons boundaries. The treaty makes a series of distinctions to define those boundaries: it distinguishes contracting parties from other states; public from private organizations; private organizations including their resources in the limited commons from others; agricultural uses from pharmaceutical uses; recipients protecting or not protecting derived products by patents or by plant breeders' rights (criterion (a)). Moreover, those distinctions aim at ensuring some congruence between access rules and contribution to the limited commons (criterion (b)).

Regarding criterion (c), the answer is again complicated by the fact that the Multilateral System was created by an international treaty and is now

ruled by a governing body, which means that the collective decisions are made by states and not by members of the agricultural R&D community. However, history of the regulation of genetic resources for food and agriculture shows that CGIAR, ASSINSEL and some others NGOs representing the members of the agricultural R&D community have been very influential in the redaction of the regulations to their sector. In addition, a group of experts coming from this community has been entrusted with the redaction of a draft of the standard MTA⁶⁰⁴. Finally, article 19 of the International Treaty provides that any organization qualified in the field may have a representative within the governing bodies, unless one-third of the contracting parties who are present object.

An important issue is the enforcement of the rules of the Multilateral System (criteria (d) and (e)). As I explained before, one of the advantages of the Multilateral System lies in the reduction of the need to monitor and sanction violations of the rules. However, some provisions such as restrictions in the claim of IPRs and requirements to share the benefits need to be enforced. Thus far, the Treaty provides little indications on this issue. Article 21 requires the governing body to set up effective procedures and operational mechanisms to monitor compliance and to sanction non-compliance. It is thus too early to assess the enforcement mechanism that should otherwise be a priority for the governing body. However, one can already affirm that the design of an efficient enforcement system will be an important test of the efficiency and the robustness of the Multilateral System.

Regarding the conflict resolution mechanisms (criterion (f)), the Treaty mentions the mechanisms usually used in international law such as negotiations, bons offices or mediation, arbitration or submission of the dispute to the International Court of Justice but nothing else. These dispute settlement mechanisms are only accessible to states and imply heavy procedures. Therefore, members of the agricultural R&D community have no direct access to a rapid and low cost conflict resolution mechanism.

As for the recognition of rights to organize (criterion (g)), the negotiators of the CBD and the FAO Conference both resolved to ask the FAO commission on plant genetic resources for food and agriculture to

⁶⁰⁴ The draft Standard Material Transfer Agreement and the minutes of the two first meetings of this "Contact Group for the Drafting of the Standard Material Transfer Agreement" are available at the following address: <http://www.fao.org/ag/cgrfa/docs.htm>

provide a forum to adapt the International Undertaking and address the issue of access to ex situ collections not addressed by the CBD (*Cf. section 5.3*). The community of agricultural R&D seized this opportunity, first to regulate access to CGIAR centers' collection, and then negotiate an entire sub-regime for PGRFA. In addition, the CBD, the Multilateral System and the CGIAR network are nested enterprises (or Russian dolls). Appropriation, provision, enforcement, conflicts resolution,⁶⁰⁵ and governance activities are organized in multiple layers of nested enterprises. Moreover, possible further layers like regional networks of genebanks or cooperation networks among breeders and research institutions could be added.

5.4.4 Emergence of Collective Rights Organization

Collective rights organizations such as the Multilateral System can enhance the welfare of their members by reducing transaction costs and/or by formalizing social norms. However, it does not mean that they will automatically emerge each time they could be useful. The literature on the conditions of emergence of such coordination mechanisms observes congruence between private institutions and the existence of **"communities"**. Could the existence of such communities contribute to the explanation for the emergence of the Multilateral System? As I mentioned in part one, in an effort to elaborate on this notion of community, Elinor Ostrom lists a series of **internal characteristics** of a group facing a collective action problem positively related to the likelihood of starting to coordinate their actions:

⁶⁰⁵ Enforcement and conflict resolution are however the weak points at each level.

1. Most members share a common judgment that they will be harmed if they do not adopt an alternative rule.
2. Most members will be affected in similar ways by the proposed rule change.
3. Most members have a low discount rate. In other words, individuals are more likely to start coordinating their actions if they highly value the continuation of their common activity.
4. Members face relatively low information, transformation, and enforcement costs. In other words, members of a group are more likely to coordinate if the costs for the group of considering a rule change, of effectively changing the rules and of monitoring and sanctioning the possible infringement of the rule are low.
5. Most members share generalized norms of reciprocity and trust that can be used as initial social capital.
6. The group is relatively small and stable (repeat interaction).

The first task in observing whether the negotiation of the International Treaty respects the criteria identified by Ostrom is to identify the relevant group or community. Once again, I am faced with the difficulty that an international treaty creates the Multilateral System. Formally, the negotiators are the Contracting Parties, i.e. a large number of states. However, behind the formal negotiators, one can identify the community of (public and private) agricultural research. This community includes two influential groups that have largely contributed to the drafting of the International Treaty either by publishing position papers or counseling national negotiators or simply by attending the negotiation meetings. Those two groups are on the one hand public sector agricultural researchers, especially scientists working for the CGIAR centers, and on the other hand traditional plant breeders represented by ASSINSEL⁶⁰⁶.

⁶⁰⁶ As mentioned in Part II, chapter 2, ASSINSEL, is an international association of private-sector plant breeders. While membership includes all type of companies, the majority of the members are small and medium sized enterprises that still tend to use plant breeders' rights more often than they use patents. In 2002 ASSINSEL merged with the International Seed Trade Federation (FIS). The new organization is now called the International Seed Federation (ISF).

Both groups played a leading role in the achievement of the first equilibrium I identified earlier (Part II, Chapter 2). The CGIAR centers were at the origin of the creation of a network of *ex-situ* collections in open-access, while plant breeders and ASSINSEL were at the origin of the creation of plant breeder rights that protect new plant varieties but leave genetic resources in open-access through the so-called breeders' exception. The two groups might have different or even conflicting views and interests in some issues but they both agree that the regime promoted by the CBD, leaning on national sovereignty and wide patenting of genetic resources, could be very harmful for agricultural R&D. As I mentioned above, CGIAR centers reacted to the adoption of the CBD by negotiating an agreement with the FAO, placing their collection of genetic resources in open-access and forbidding recipients to protect the accessed material in the form received. Plant Breeders and ASSINSEL first reacted to the possibility of patenting genetic resources by adapting the UPOV Convention in 1991 (Part II, Chapter 3). Notably, in a document entitled "*ASSINSEL Position on Maintenance of and Access to Plant Genetic Resources for Food and Agriculture*"⁶⁰⁷ adopted in 1996, plant breeders express their dissatisfaction with the CBD, which contrary to its objectives renders access to genetic resources more difficult. They then affirmed that the "*best solution to improve or at least maintain current level of access to PGRFA in the new era of the CBD is to establish [...] a multilateral agreement for [...] and ensuring free access to PGRFA*". Two years later, ASSINSEL members agreed on another position paper entitled "*Position on Access to Plant Genetic Resources for Food and Agriculture and the Equitable Sharing of Benefits Arising from their Use*"⁶⁰⁸. Plant Breeders reaffirmed their criticisms of the CBD and their desire to create a multilateral system. Then, they added that the multilateral system should include a Standard Material Transfer Agreement that should include the following provisions. First, the recipient should not be allowed to claim legal ownership nor apply for intellectual property protection for the germplasm received *per se*. Thus, plant breeders agreed not only among themselves but also with CGIAR centers that genetic resources may not be appropriated under the form received. Second, they affirmed that recipients may protect products derived from the received genetic resources either by plant breeders' right or by patent. Third, they added that *in the event of protection through patents, limiting free access to the new genetic resources, ASSINSEL members are prepared to study a system in which the owners*

⁶⁰⁷ The text of ASSINSEL's position is available on its website <http://www.worldseed.org>

⁶⁰⁸ *Ibidem*

of the patents would contribute to a fund established for collecting, maintaining, evaluating, and enhancing genetic resources.

Therefore, it can be said that the agricultural R&D community do meet the first criteria identified by Ostrom: most members share a common belief that their activities will be harmed if they do not adopt an alternative rule. Regarding the second criteria that the proposed rule change will affect most members in similar ways, the question must be subdivided. All members of the Agricultural R&D community will probably equally benefit from a multilateral system turning national sovereignty into open-access. In contrast, they will not be affected in the same way by limitations to IPR protections. CGIAR centers and public sector researchers are little or not interested in IPRs whereas plant breeders are. That is probably why they took more time to agree on this issue and draw the option either to increase the limited commons by placing in open access products derived from received genetic resources, or by contributing to a fund dedicated to conservation.

Concerning the third criteria, one can easily assert that most members of the agricultural R&D community highly value the continuation of their common activity as plant breeding and conservation are long term activities; plant breeding companies, research organizations and CGIAR centers are not planning to leave the sector. As for the fourth criteria, it can be said that the creation of the Multilateral System has been facilitated by organizations that provide members with information on the potential impact of rule change and by the existence of places where they can exchange views on those potential changes. The CGIAR and ASSINSEL carry out studies for their members and enable them to coordinate their views. Then, the FAO Commission Plant Genetic Resources for Food and Agriculture (CPGRFA) equally provides similar surveys⁶⁰⁹ and an institutional framework to negotiate rule change. Regarding enforcement costs, as I said earlier, the Multilateral System actually reduces the need to monitor recipients and to some extent could provide a cheaper centralized enforcement mechanism.

Regarding Ostrom's fifth and sixth criteria, I have already repeated several times that the agricultural R&D community has long been ruled by norms of shared and reciprocal access and that public scientists and plant breeders have developed extensive networks of cooperation. Actually, members fear that an access and benefit-sharing regime based

⁶⁰⁹ Some of these "Background Study Papers" are available at the following address: <http://www.fao.org/ag/cgrfa/docs.htm>

on exclusive rights (national sovereignty and patent) threatens their norms and their cooperative networks. The creation of the Multilateral System and the explicit exclusion of the pharmaceutical sector is a means to protect those norms and those cooperation networks.

In conclusion, it seems that the agricultural R&D community possesses most of the internal characteristics identified by Ostrom as being positively related to the likelihood of this community adopting a series of incremental changes in the rules to improve their joint welfare. This might help to explain why this community managed to change the ABS rules for their sector, completely modifying the logic of the CBD and to some extent recreating the preexisting regime.

In this chapter, I explained how the agricultural R&D community created its own access and benefit system by turning the CBD regimes based on exclusive rights and bilateral contracts into a multilateral system of access and benefit sharing. It is too early to assess the efficiency of the International Treaty because this multilateral system only entered into force on 29 June 2004. Moreover, many details must still be settled by the Governing Body, notably in the Standard Material Transfer Agreement currently in negotiation. However, an analysis of the Treaty in light of a few bodies of theoretical literature seems to indicate that it contains promising characteristics. I now turn to a broader conclusion on the evolution of genetic resources property regimes.

Conclusion and Future Developments

Synthesis

The objective of this second part was to give a better understanding of the property regime for genetic resources and its evolution. To this end, I reconstructed a history of this regime and used the theories identified in part one as explanatory tools.

I started by introducing the notions of biodiversity and genetic resources as knowledge goods. Then, I explained that we face two challenges: favoring agricultural and pharmaceutical innovation on the one hand (downstream), and conserving and ensuring access to genetic resources, the sources of innovation, on the other hand (upstream). I characterize conservation and innovation as knowledge production activities, i.e. two public goods that can be provided either by public funding or by IPRs and/or similar devices. In the second chapter of this section I identified a first equilibrium that resorts to both IPRs to fund R&D, and to public funding to ensure conservation and a complementary R&D effort. Some coherence is found in the open access to genetic resources as a source of innovation, however mainly in favor of agricultural innovation and plant breeders. In the third chapter I argued that this equilibrium has been contested by two changes. Changes in conservation needs and technological changes promote the adoption of exclusive rights both upstream (national sovereignty) and downstream (patent) of the innovation chain. These two changes prepare for the adoption of the CBD, which in turn provides an outline for a regime of access and benefits based on exclusive rights (national sovereignty and patent) and bilateral contracts. In the fourth chapter I described the CBD and the process of implementation at the national level. Then, I assessed the first decade of implementation. I argued that the regime settled by the CBD has had limited success so far due to the unanticipated presence of high transactions costs.

At the end of chapter four I described some existing or proposed improvements of the ABS regime aiming at reducing transaction costs. In chapter Five, I analyzed how the agricultural R&D community estimated that the CBD regime did not fit its activities, which are characterized by a process of collective innovation, nor did it fit its social norms, which are characterized by shared-access and reciprocity. As a result, the agricultural R&D community created its own regime that

ultimately fits into the legal framework set up by the CBD, though it completely modifies its logic. I then observed the extent to which the solutions identified in the first part of this dissertation have been employed to overcome transaction costs and maintain social norms. To that end I first suggested that devices within the International Treaty on Plant Genetic Resources can be analyzed in terms of liability rules and collective rights organization. I then noted how the International Treaty creates a limited commons, i.e. property held as a commons among the members of a group but exclusively vis-à-vis the outside world, which is modified by some elements of open access and open-content. Finally, I used Elinor Ostrom's work to examine the resilience of the regime created by the Treaty (design principles) and its process of emergence.

Future Developments

Today we have two regimes for access and benefit sharing (ABS): the multilateral ABS regime set up by the International Treaty for agrobiodiversity and a regime of exclusive rights and bilateral contracts established by the CBD for the rest of biodiversity. It will be interesting to compare the efficiency of the two systems.

It is too early to assess the efficiency of the multilateral system because its implementation is too recent and because its Governing Body must still design some important elements. However, the theoretical analysis I have undertaken seems to indicate that it contains promising elements. Regarding the CBD, neither providing countries nor users are fully satisfied with its current state of implementation. In 2002, the World Summit for Sustainable Development called for action to *negotiate within the framework of the Convention on Biological Diversity, bearing in mind the Bonn Guidelines, an international regime to promote and safeguard the fair and equitable sharing of benefits arising out of the utilization of genetic resources.*⁶¹⁰ The CBD *ad hoc* Working Group on Access and Benefit Sharing is now in charge of identifying the process, nature, scope, elements and modalities of an international regime and provides advice to the Conference of the Parties.

⁶¹⁰ World Summit on Sustainable Development held in Johannesburg in September 2001, *Plan of Implementation*, Paragraph 44 (o)

In its report to the eighth Conference of the Parties⁶¹¹, the Working group considered the possibility of setting up the instruments I mentioned in Chapter Four: disclosure of origin and certificate of origin/source/legal provenance. It is impossible to anticipate the results of the discussion but it seems that envisaged changes would not dramatically modify the current logic: exclusive rights and bilateral contracts. Despite the appellation of the international regime, envisaged changes are seen to be more flanking measures to facilitate the enforcement of bioprospecting contracts and ABS legislation rather than an alternative regulation of genetic resource exchanges.

The coexistence of two regimes of access and benefit sharing and the fact that the CBD regime is now under review calls not only for comparative assessment but also for a **closer look at the boundary between these two regimes**. Currently, the multilateral regime rules access to a limited list of plant genetic resources for food and agriculture uses and benefit sharing. The CBD regime rules all other situations. One can see two main justifications for such a boundary. The first one relates to the distinctive characteristics of innovation in the agricultural R&D community. The second one concerns institutional matters, the FAO has a long tradition of dealing with genetic resources for food and agriculture. These are valuable criteria; however, it might be worthwhile to consider alternative distinctions.

A first distinction might be whether genetic resources are held in an *ex-situ* collection, or at least if they are well identified and easily accessible, or whether they are *in situ*, unidentified, and not immediately accessible. Indeed, when resources are in an *ex-situ* collection or well identified and easily accessible, the object of the contract is an immediate transfer of a sample of genetic resources. By contrast, when genetic resources are *in-situ*, unidentified and not immediately accessible, the object of the contract is not an immediate transfer but the work of collecting, identifying, and then transferring the resources. Regarding the first case, I believe the multilateral system might be useful at reducing transaction costs and facilitating those numerous, repeated and immediate transfers. Regarding the second case, the multilateral system of facilitated access offers little interest. Those kinds of contract are more likely to be joint

⁶¹¹ CBD (2006) *Report of the Eighth Meeting of the Parties to the Convention on Biological Diversity*, UNEP/CBD/COP/8/31

ventures or other kinds of long term contracts between the providing country and the users.⁶¹²

A second distinction might be whether exchanges and capacities to benefit from the exchanges are symmetrical or asymmetrical. The main benefit of the limited commons (or shared access) created by the multilateral system is facilitated access; each member has access to more genetic resources than he provides. However, this sort of benefit sharing is only valuable by those who have the skills to use genetic resources for research purposes. The developing countries were very critical of the asymmetry of research skills under the International Undertaking. Therefore, a multilateral system might only attract members whose contributions and capacities to share the benefits are symmetric unless it includes rules of compensation for countries providing the system with genetic resources without being able to enjoy its benefits.

If these suggestions have some accuracy, providers and users of genetic resources are likely to contract their rights to tailor the ABS systems to meet their specific needs. One can already observe the first steps of this process. At least two technical communities are setting up regimes of access and benefits sharing that comply with the provisions of the CBD, though they implement it according to the specificities of their practices. The European Consortium of Botanical Gardens has recently created the International Plant Exchange Network (IPEN). Collections of microbiological resources are now setting up their own system of management of access to and transfer of microbiological resources (MOSAICS). These two emerging initiatives share some common characteristics not only between them but also with the Multilateral System created by the International Treaty or the Uniform Biological Material Transfer Agreement analyzed in the first part of this dissertation. Schematically, both include a common system of identification of resources that might lower search costs, standard material transfer agreements to reduce bargaining costs, and tracking systems to lower monitoring costs. Last, they both create a system of free and shared-access for research purposes. Therefore, one important theme in the discussions on the regulation of access to genetic resources and benefits could be to better understand when and how the law could facilitate and regulate the emergence of these collective rights organizations (or other forms of self-regulation).

⁶¹² For a thoughtful analyze of these complex contractual mechanisms see Padmashree Gehl Sampath (2005), *Regulating Bioprospecting: Institutions for Drug Research, Access and Benefit Sharing*, Tokyo: United Nations University Press

Two important issues have not been dealt with in this Second Part. First, it is now clear that neither the CBD nor the International Treaty will generate enough benefit sharing to fund the conservation of biodiversity that must be mainly carried out in poor developing countries. It is worthwhile to get back to the first issue: the balance between what is publicly funded and what is privately funded with the help of IPRs. It seems well that upstream parts of the chain of innovation, either basic research or conservation (*Cf. chapters two of part one and part two*). The conservation of biodiversity will be funded by the private sector as long as a minimal rate of return can be expected. The public sector finances conservation where the expected social benefit is high and the private benefit low. For the most *in situ* conservation corresponds to this last situation. I have already mentioned the important social benefit of conservation; I just recall that after a few years of illusion it appears that the expected private benefit from conservation (at least *in situ* conservation) is low for different reasons. First, the economic value of conservation is difficult to forecast and even to assess retrospectively. As most biodiversity is little known, the outcome of conservation is highly uncertain. Second, the difficulty in establishing and defending property rights in “raw” genetic resources (*Cf. chapter 4*) often impedes the realization of economic rent. This means that we have to find other sources of funding for conservation. It could also call into question the idea that sustainable use can fund conservation and announce a renewed emphasis on protected areas as the main way to conserve biodiversity.

Second, I have not mentioned the traditional knowledge of indigenous and local communities, specifically with regards to the conservation and use of genetic resources. There is a growing interest among genetic resources users for accessing simultaneously associated traditional knowledge. Access to traditional knowledge and benefit sharing can be ruled either by national ABS legislation and bioprospecting contracts or by intellectual property. This is the subject of the next part of this dissertation.

Part Three:
The Property Regime
of Traditional Knowledge

Introduction

The objective of Part Three is to provide a better understanding of traditional knowledge property regimes and their evolution. Over the last decades, there has been a growing interest in the traditional knowledge of indigenous and local communities. Paradoxically, despite this growing interest, traditional knowledge is quickly eroding. This combination has elicited a demand for protection for traditional knowledge. In this third part, I analyze the ongoing discussions on the protection of traditional knowledge and I identify some limits of the considered solutions. I then suggest adopting a different perspective in order to explain the limits of the solution, to identify interesting practical experiences in the protection of TK, and to provide some guidance for designing effective institutional mechanisms to protect TK.

To that end, I reconstruct a history of traditional knowledge property regimes with the help of the theories I introduced in Part One. There are important parallels with the historical account of the evolution of intellectual property systems and the evolution of genetic resources property regimes. However, there are two important differences with the first two parts of this dissertation. First, the debate on TK protection is recent and far from concluded. Time has not yet tested the efficiency of considered solutions. Second, in this third part, I only deal with the upstream side of the innovation chain. I have described the downstream side of the innovation chain in Part Two; final users of TK and genetic resources are the same: bio-industry. Here, the issue is to combine the two functions of traditional knowledge: first, traditional knowledge consists of practices and information useful and vital to the daily life of TK holders; second, traditional knowledge has become in addition valuable source of information for modern science.

In accordance with the perspective suggested above, I begin by examining what were the content and the nature of the property regime organizing traditional innovation before TK protection appeared in international discussions. It is important to recognize that there does exist some intellectual property protection in these communities. With that in mind, I suggest that local and indigenous communities holding TK can be analyzed as systems of innovation. I also suggest that ‘traditional innovation’ is organized by customary intellectual property law that both creates forms of ownership over knowledge and regulates exchanges of knowledge.

In the third chapter I describe two changes that lead to a demand for protection of traditional knowledge and for the consideration of customary law. Downstream of the chain of innovation, scientists, development agencies, and bio-industries show a growing interest for TK. Paradoxically, on the upstream side of the chain of innovation (within communities), traditional knowledge is eroding.

In the fourth chapter I stress a few difficulties that must be taken into account in researching the best means of conserving and further using traditional knowledge. First, in view of the growing interest of outsiders for TK, customary (informal) property regimes may no longer be sufficient to regulate uses of TK. Second, the nature of TK and of its mode of transmission hinders its conservation and its use by third parties.

In the fifth chapter, I analyze the current attempts to protect traditional knowledge and to define property rights. First, I recount the ongoing discussions within the World Intellectual Property Organization and I identify some limits of the considered solutions. Second, I examine examples of practical experiences of protecting TK. Third, in accordance with the perspective adopted in this dissertation, I suggest that any effort to design property rights over TK should take into account the nature of this knowledge, its usefulness and the incentive effect of such property rights. This analysis and practical experience converge towards the creation of TK databases as a useful instrument for protection.

In the sixth chapter, I observe the lack of progress in the ongoing discussions on the possible role of customary law in the protection of traditional knowledge. Then, I suggest adopting the same perspective I adopted in the first two parts of this dissertation. As a result, the discussion on customary law appears to be an issue of self-regulation. As customary law governs protection inside the community, it therefore appears that the issue is not so much the protection of TK inside the community but rather how custom-based innovation systems can be articulated within the existing framework of global intellectual property law. I observe how some communities try to formalize and enforce their customary law with a combination of property rights and contracts.

In the last chapter, I look at further developments that could help protect traditional knowledge and foster its use.

1. The Notion of Traditional Knowledge

The Convention on Biological Diversity (CBD) calls for the respect, preservation, maintenance and promotion of the wider application of traditional knowledge (TK). However, it contains no definition of traditional knowledge. Article 8j only refers to “*innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity*”. Actually, there is neither generally agreed definition of TK nor even a common term to designate this kind of knowledge⁶¹³. Participants to the discussions on TK protection use different expressions and definitions to designate traditional knowledge according to the aspect of TK they want to emphasize.

1.1 Traditional innovation

As I examine TK protection in relation to IPRs, I start with a definition used by the secretariat of WIPO in the conduct of its fact-finding missions on traditional knowledge. The term “traditional knowledge” *refer[s] to tradition-based literary, artistic or scientific works; performances; inventions; scientific discoveries; designs; marks, names and symbols; undisclosed information; and all other tradition-based innovations and creations resulting from intellectual activity in the industrial, scientific, literary or artistic fields.* The secretariat adds that “*tradition-based*” *refers to knowledge systems, creations, innovations and cultural expressions which: have generally been transmitted from generation to generation; are generally regarded as pertaining to a particular people or its territory; and, are constantly evolving in response to a changing environment.* In this sense, TK is identified by its mode of production and transmission.

The ongoing discussions on the protection of TK force us to revise the often-made assumption that there is no creativity among indigenous and local communities and more broadly in the third world⁶¹⁴. In this sense “*what is “traditional” about traditional knowledge is not its antiquity, but the way it is acquired and used. In other words, the social process of learning and sharing knowledge, which is unique to each indigenous culture, lies at the very heart of its*

⁶¹³ For a list various terms given to traditional knowledge see for instance WIPO (2002) *Traditional Knowledge – Operational Terms and Definitions*, WIPO/GRTKF/IC/3/9, p. 18

⁶¹⁴ Ruth L. Gana (now Ruth L. Okediji) (1995), “Has Creativity Died in the Third World? Some Implications of the Internationalization of Intellectual Property”, 24 *Denver Journal of International Law and Policy* 109, hereafter Ruth L. Gana (1995) “Has Creativity Died...”

*“traditionality.” Much of this knowledge is actually quite new, but it has a social meaning, and legal character, entirely unlike the knowledge indigenous peoples acquire from settlers and industrialized societies.”*⁶¹⁵ Traditional knowledge designates one system of knowledge creation⁶¹⁶ that has been developed within specific cultural groups, over a specific period of time, and within specific environmental and social settings, like any other system of knowledge.⁶¹⁷ TK is embedded in specific worldviews. For instance, in contrast to science, which has a strongly instrumental view about man’s relation to nature, traditional innovation emphasizes the symbiotic nature of the relationship between humans and the natural world. TK holders tend to view peoples, animal and plants and other elements of the universe as interconnected through a network of relations and obligations.⁶¹⁸

1.2 The Holders of Traditional Knowledge

Traditional knowledge can also be identified and classified according to its holders as it done in article 8J of the CBD calling for the protection of local and indigenous communities’ knowledge. The expressions “local communities” and “indigenous peoples” are not synonymous.

The expressions “indigenous communities” or “indigenous peoples” have been the subject of considerable discussion and study, however, most analysts use the “Cobo’s description” as a working definition. The Cobo’s description requires three elements: 1) precedence on a territory, 2) non-domination, and 3) an identity claim: “*indigenous communities, peoples and nations are those which, having a historical continuity with pre-invasion and pre-*

⁶¹⁵ Russel L. Barsh (1999), “Indigenous Knowledge and Biodiversity, in Indigenous Peoples, Their Environments and Territories”, in D.A. Posey (ed.) *Cultural and Spiritual Values of Biodiversity*, IT Publications & UNEP, p. 73. See also WIPO (2001) Report on Fact Finding Missions on Intellectual Property and Traditional Knowledge (1998-1999), WIPO Publications No 768E

⁶¹⁶ In the same sense, Indian scientists involved in the documentation of traditional knowledge note that traditional knowledge systems include not only knowledge which is traditional in the sense that it is transmitted from one generation to another but also traditional way of knowing that may constantly be at the origin of innovations. P. Vivekanandan *et al.* (2004) “Protecting Traditional Knowledge of small, scattered and disadvantaged grassroots innovators and traditional knowledge holders: A Honey Bee perspective and Agenda for Policy and Institutional Change”, Paper presented at a UNCTAD-Commonwealth workshop, Geneva 4-6 February available at http://r0.unctad.org/trade_env/test1/meetings/tk2.htm

⁶¹⁷ International Council for Science (2002), *Science, Traditional Knowledge and Sustainable Development*, ICSU Series on Science for Sustainable Development, No. 4, p. 9

⁶¹⁸ *Ibidem*, see also Anna Fienup-Riordan (1990) “Original Ecologists? The Relationship between Yup’ik Eskios and Animals” in A. Fienup-Riordan (ed.) *Eskimo Essays*, London: Rutgers UP

colonial societies that developed on their territories, consider themselves distinct from other sectors of the societies now prevailing in those territories, or part of them. They form at present non-dominant sectors of society and are determined to preserve, develop and transmit their ethnic identity, as a basis of their continued existence as peoples, in accordance with their own cultural patterns, social institutions and legal systems."⁶¹⁹

Indigenous peoples' struggle for the recognition of their rights has a long and proper history⁶²⁰. Their demands concern a larger range of issues than the protection of TK. Roughly speaking, their demands can be summarized as a general struggle for self-determination, i.e. accession to statehood or at least some form of larger autonomy. The fact that indigenous communities hold an important proportion of TK has influenced the discussions on TK protection, notably giving a very high profile to the role of customary law (*Cf. Chapter Six*).

If the notion of indigenous communities is defined and concerns mainly peoples in the Americas and in Oceania⁶²¹, in contrast, the term "local community" is not strictly defined and is used to refer to communities in the rest of the world, notably in Africa and in Asia, which have traditional ways of life and maintain live traditional knowledge concerning biological resources. In this dissertation, I do not insist on this division; to the contrary, I emphasize similarities between the two categories of holders.

Last, for the sake of precision it must be said that TK is produced within communities but it does not mean that the community collectively owns individual elements of TK. Local and indigenous communities hold TK in the sense that they determine community and individual's rights to knowledge. Within local and indigenous communities, customary law or social norms rule the ownership of traditional knowledge. In this dissertation, I do not distinguish between the expressions "social norms" and "customary law". Both of these terms are defined by regular behaviors in which people engage out of a sense of obligation. Indigenous communities prefer the expression "customary law" because they regard it as their legal system. Customs can become law if the formal legal system gives them legal force. However, it is often not the

⁶¹⁹ U.N. Subcommission on Prevention of Discrimination and Protection of Minorities (1983) *Study of the Problem of Discrimination against Indigenous Populations*. José Martínez Cobo, special rapporteur. U.N. Doc. E/C.N.4/Sub.2/1986/7 and Addenda 1-4

⁶²⁰ See for example S. James Anaya (1996), *Indigenous Peoples in International Law*, New York – Oxford: Oxford University Press or Isabelle Schulte-Tenckhoff (1997), *La question des peuples autochtones*, Bruxelles-Paris: Bruylant-L.G.D.J

⁶²¹ Including European states' territories in these continents

case, especially for intellectual property-related provisions of customary law.

1.3 Sectors in Traditional Knowledge

Local and indigenous communities are involved in biodiversity management, conservation and trade in genetic resources. Living in close proximity to biodiversity, local communities have developed traditional knowledge and management systems that are closely linked with the natural resources over which they have long been stewards and managers⁶²². Traditional knowledge may be useful in a large range of sectors. Types of traditional knowledge include agricultural knowledge, medical knowledge, ecological knowledge and cultural knowledge. Traditional agricultural knowledge may include the understanding of soil composition and its use in agriculture (ethnopedology), the knowledge and use of animal phenomena, especially in pest control (ethnozoology), and the knowledge of forest management techniques, natural pest repellent techniques, and other cultivation methods (ethnoagriculture and agroforestry). Traditional ecological knowledge (or ethnoecology) includes the understanding and cultivation of distinct ecosystems or ecological zones and practices relevant for their conservation and sustainable use.⁶²³ Traditional medical knowledge designates knowledge on the use of plants and animals in traditional medicine.⁶²⁴ Lastly, traditional cultural knowledge or folklore includes forms of music, dance, song, handicrafts, designs, stories and artwork

Some elements of the following chapters may apply to all TK. However, in this dissertation, I will not deal with the specific characteristics of cultural knowledge designated by WIPO as “traditional cultural expressions” or “expressions of folklore”; rather, I focus on the portion of traditional knowledge, sometimes referred as ethnobotanical knowledge, that concerns uses and conservation of genetic resources,

⁶²² Kerry Ten Kate and Sarah Laird (1999), *The Commercial Use of Biodiversity* Earthscan, London, p. 6 hereafter Ten Kate et Laird (1999) *The Commercial Use of Biodiversity*...

⁶²³ Darrel A Posey (1985), “Indigenous management of tropical forest ecosystems: the case of the Kayapo Indians of the Brazilian Amazon”. 3 AGROFORESTRY SYSTEMS 139-158

⁶²⁴ The World Health Organization (WHO) has offered the following conceptualization of traditional medicine: “*The sum total of the knowledge, skills and practices based on the theories, beliefs and experiences, indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illnesses.* WHO (2000) *General Guidelines for Methodologies on Research and Evaluation of Traditional Medicine*, Geneva: WHO/EDM/TRM/2000

which can be useful information for agricultural and pharmaceutical research and development (R&D) and for environmental conservation.⁶²⁵

1.4 Traditional Knowledge as Information

In international discourse, it is not always perfectly clear whether the expression “traditional knowledge” designates only intangible elements (knowledge or information) or both tangible and intangible components. In that case, the tangible component of TK actually refers to genetic resources. Indeed traditional knowledge can be embodied or incorporated into genetic resources. When bio-industries want to access genetic resources, they can use either genetic resources in their natural state or genetic resources that have been “improved” by man. When traditional farmers have improved genetic resources, it is considered that that these genetic resources embody traditional knowledge. In this dissertation, I look at both the tangible and intangible elements of traditional knowledge. I deal with the tangible aspects of TK in the second part, which is dedicated to genetic resources. In this third part, I concentrate on the use and conservation of the intangible elements of traditional knowledge (information).

1.5 The Two Functions of Traditional Innovation

In the discussion on the protection of traditional knowledge, it is important to understand the two functions played by traditional innovation. First, traditional knowledge is useful and vital for traditional knowledge holders themselves. The International Council for Science observes: *traditional knowledge provides the basis for local-level decision making about many fundamental aspects of the day to day life: hunting, fishing, gathering, agriculture and husbandry; preparation, conservation and distribution of food; location, collection and storage of water; struggles against diseases and injury; maintenance of shelter; orientation and navigation on land and sea; management of ecological relations for society and nature; adaptation to environmental :social change;*

⁶²⁵ Expressions of folklore and traditional cultural expressions have been the object of a long work both at national and international level. In 1982, UNESCO and WIPO adopted the *WIPO/UNESCO Model Provisions for National Laws on sui generis Protection of Expressions of Folklore against Illicit exploitation and other prejudicial actions*. A large range of countries have enacted legislation to protect their folklore. Last, the protection of expressions of folklores and traditional cultural expressions is currently discussed in WIPO. See WIPO (2006) *The Protection of Traditional Cultural Expressions/ Expressions of Folklore: Revised Objectives and Principles*, WIPO/GTRKF/IC/9/4

*an so forth and so forth*⁶²⁶. Regarding traditional medicinal knowledge, the World Health Organization estimated that as many as eighty percent of the world's population depend on traditional medicine for their primary health care needs⁶²⁷. Second, traditional knowledge is also an important source of information for modern science. Traditional knowledge has informed modern science in many areas, most notably in taxonomy, medicine, agriculture, natural resource management and conservation. Bio-industries have turned some elements of TK into end products such as seeds or medicines. Therefore, it can be said that traditional innovation is both an autonomous innovation system and a source of innovation (upstream of the innovation chain) for science and bio-industries.

⁶²⁶ International Council for Science (2002), *Science, Traditional Knowledge and Sustainable Development*, ICSU Series on Science for Sustainable Development, No. 4, p. 9

⁶²⁷ WHO, IUCN and WWF (1993), *Guidelines on the Conservation of Medicinal Plants*, Gland, (Switzerland): IUCN

2. A First Equilibrium: The Former Situation of TK

For a decade or two, the protection of traditional knowledge (TK) has been the subject of numerous discussions first among non-governmental organizations, then among academics and now within intergovernmental organizations. Before examining the solutions currently discussed, I believe it is useful to have a careful look at the early situations of traditional knowledge before these discussions were launched. In this chapter I pay special attention to the traditional property regime of TK and the modes of TK transmission.

2.1 The Property Regime

Debates about international protection of intellectual property, and more precisely protection of TK, often erroneously assume that intellectual property regulation does not exist within indigenous and local communities. To fully understand TK protection it must be recognized that there does exist some intellectual property protection within these communities.⁶²⁸ TK holders repeatedly claim that they do not want classical intellectual property laws but rather recognition of their customary intellectual property law.

With this perspective, I suggest that local and indigenous communities be analyzed as systems of innovation whereby ‘traditional innovation’ is organized by customary intellectual property law that (1) creates forms of ownership to knowledge and (2) regulates exchanges of knowledge. Therefore, it is worth examining the content and the nature of the property regimes which organized traditional innovation before TK protection entered into international discussions.

2.1.1 The Content of the Property Regime

Social norms or customary laws regulating traditional innovation are difficult to document because the awareness that customary laws include provisions on knowledge ownership (and not only a sharing ethos opposed to any idea of appropriation) is recent. If the anthropological literature and property rights scholarship contain plenty of descriptions of community norms or customs that organize community based

⁶²⁸ Ruth L. Gana (1995) “Has Creativity Died...”

systems of property rights to land⁶²⁹, Cleveland and Murray observe that there is unfortunately no comprehensive study of customary intellectual property law available.⁶³⁰ However, they add that ethnographic examples make it clear that local and indigenous communities have notions of intellectual property and that these rights might exist at the individual level and/or group level based on residence, kinship, gender, or ethnicity. Their assertion is confirmed by several reviews of the anthropological literature⁶³¹ and the results of the Fact-Finding Missions of WIPO⁶³² that identify several forms of intellectual property reminiscent of copyright, trademark or patent. For instance, in Papua New Guinea, the customary law of some communities provide for certain forms of individual ownership over knowledge that is related to healing practices, designs, songs, and dances which may be created and owned by individuals who can use them or exchange them for payment⁶³³. Similarly, customary private property can also be found in other Melanesian communities⁶³⁴ and other parts of the world, notably the Shuar⁶³⁵, the Miskito healers⁶³⁶ and the Siona.⁶³⁷ Lastly, the Four Directions Council, a Canadian indigenous peoples organization claims

⁶²⁹ See for instance CIEL, 2002, *Whose Resources? Whose Common Goals? Towards a New Paradigm of Environmental Justice and the National Interest in Indonesia*. See chapter one: "Community-Based Property Rights: A conceptual Note"

⁶³⁰ David A. Cleveland and Stephen C. Murray (1997) "The World's Crop Genetic Resources and the Rights of Indigenous Farmers, 38 *CURRENT ANTHROPOLOGY* 477, at 483

⁶³¹ Thomas Griffiths (1993) "Indigenous Knowledge and Intellectual Property: A preliminary Review of the Anthropological Literature, unpublished paper, quoted by Graham Dutfield (2000) "The Public and Private Domains, Intellectual Property Rights in Traditional Knowledge", 21 *SCIENCE COMMUNICATION* 274-295, and Paul Kuruk (1999) "Protecting Folklore under Modern Intellectual Property Regimes: A Reappraisal of the Tensions between Individual and Communal Rights in Africa and the United States, 48 *AMERICAN UNIVERSITY LAW REVIEW* 769-849, Ruth L. Gana (1995) "Has Creativity Died..."; see also Harold E. Driver (1962) *The Indians of North-America*, Chicago: The University of Chicago Press, p. 221 who observes that all Native American Groups recognized ownership rights in intangible property.

⁶³² WIPO (2001) *Report on Fact Finding Missions on Intellectual Property and Traditional Knowledge* (1998-1999), WIPO Publications No 768E

⁶³³ J. L. Simet (2000) "Copyrighting Traditional Tolai Knowledge," in K. Whimp & B Mark, *Protection of Intellectual, Biological & cultural property in Papua New Guinea*, Asia Pacific Press, pp. 62-80

⁶³⁴ Lamont Lindstrom (1990) *Knowledge and Power in a South Pacific Society*, Washington: Smithsonian Institution Press

⁶³⁵ Janet W. Hendriks (1988), "Power and Knowledge: Discourse and Ideological Transformation among the Shuar", 15 *AMERICAN ETHNOLOGIST*, 216-138

⁶³⁶ Philip A. Dennis (1988), "Herbal Medicines among the Miskito of Eastern Nicaragua", 42 *Economic Botany* 16-28

⁶³⁷ E. Jean Langdon (1986), "Las clasificaciones del Yaje dentro del Grupo Siona: Ethnobotanica, Ethnoquimicae", 46 *AMERICA INDIGENA* 101

that “Indigenous peoples possess their own locally-specific systems of jurisprudence with respect to the classification of different types of knowledge, proper procedures for acquiring and sharing knowledge, and the rights and responsibilities which attach to possessing knowledge, all of which are embedded uniquely in each culture and its language.”⁶³⁸

It is difficult to provide a detailed description of the customary intellectual property law provisions, because provisions change from one community to another and because customary laws are not always documented and easily accessible for outsiders. However, there do exist some reviews of different customary intellectual property laws identifying some common traits among those laws. Some of these common traits differentiate customary intellectual property law from intellectual property law but there are also some common characteristics. Professor Okediji (at that time called Gana) identifies five common traits of customary intellectual property law that differentiate themselves from classical intellectual property law.⁶³⁹ A first difference is that the forms of ownership in local and indigenous communities are different. They do not put the same emphasis on the right to exclude others and the right to dispose of the property as one desires. They identify “owners” of elements of TK but this ownership is more like stewardship than ownership, and often does not include a right to exclude others from use. Furthermore, ownership rarely includes the right to transfer the knowledge to outsiders. A second difference in the treatment of intellectual property lies in the purpose of protection; motivation for creativity is less central and intellectual property is also used to preserve the integrity, sacredness and sanctity of some works. A third difference is that the theories of creation are not the same. Less attention is given to individual genius, and more recognition is given to the contribution of the group, nature and even the god(s). A fourth difference is that members of a community often jointly hold intellectual property (individual intellectual property rights do, however, exist). And finally, the organizing principles of these communities vary, and therefore they have different ideas of what is the appropriate subject of private ownership.

There is, however, as observed by Ruth Okediji, an important similarity between customary intellectual property law and classical intellectual

⁶³⁸ Four Directions Council (1996) *Forests, indigenous peoples and biodiversity. Contribution of the Four Directions Council to the Secretariat of the Convention on Biological Diversity*, Lethbridge: FDC.

⁶³⁹ Ruth L. Gana (1995) “Has Creativity Died...”, pp. 132-136

property law: *both aim, ultimately, to enhance public welfare by protecting the fruits of creative efforts*⁶⁴⁰.

It is difficult to draw general conclusions about a large numbers of indigenous and local communities and their specific property regime, but it is fairly safe to consider that these property regimes include two elements. First, customary intellectual property laws differentiate insiders (members of the community ruled by customary laws) from outsiders. Second, customary laws or norms determine what knowledge all members must share and what knowledge may be individually appropriated. As an illustration, Matthias Leistner observes that *"the flexible combination of individual and collective elements in the development of TK leads to various model of ownership depending on the predominance of either collective or individual contributions. Thus, the owning collective is not necessarily the whole local community but may also be a moiety, a clan, a phatry, a lineage, a society (or sodality) or a single household. And even individuals – for example shamans and/ or healers in certain Indian Tribes – can distinguish themselves in some case as separate creators or inventors."*⁶⁴¹

2.1.2 Nature of the Regulation: Customary Law or Social Norms

If there is some intellectual property protection in these communities, it is important to understand that the nature of this protection is quite different from formal intellectual property law. The nature of the rule is different: protection is not ensured by formal law, but rather by customary law or social norms.⁶⁴² The origin of norms and customs is also distinct, they are not created in a centralized or "top down" way by the state, and rather they have a social or "bottom-up" origin defined by two ingredients: a practice ("what people do") and a sense of obligation. Norms and customs differ from law not only by their conditions of emergence but also by their mechanism of enforcement. While violations

⁶⁴⁰ *Ibidem*, p. 136

⁶⁴¹ Matthias Leistner (2004) "Traditional Knowledge" in Silke von Lewinski (ed.), *Indigenous Heritage and Intellectual Property. Genetic Resource, Traditional knowledge and Folklore*, Kluwer Law International, p.57 (footnotes omitted).

⁶⁴² In the following paragraphs I use the expressions "social norms" and "customary law" as equivalent; both are defined by two elements: a regular behavior (1) in which people engage out of a sense of obligation (2). The expression "customary law" may suggest a claim for self-determination and it is used by indigenous peoples. In some legal systems, customary law may also be given legal force. The expression "social norms" is not related with self-determination and may be used in a larger range of situations.

of the law are monitored and punished by state actors, enforcement of social norms (and customary law as long as it has not been given legal force) is decentralized and ensured by private actors (peer supervision). As to sanctions imposed on norms violators, they range from informal gossip to exclusion from the group. Compliance with norms is insured by non-legal sanctions but may also be facilitated by rewards.

2.1.3 Property Regime as Perceived by Outsiders

If there is some intellectual property protection within indigenous and local communities that rules access and use of TK among members, the status of TK is very different for outsiders. Indeed, from their point of view TK seem to be in the public domain or in open-access for several reasons. First, statutory intellectual property laws and other legal regimes do not restrict the use of TK. Second, outsiders have no incentive to respect customary law in the interest of the community because community leaders have no jurisdiction on them and cannot impose them customary sanctions ranging from censures to fines, to ostracism or even expulsion from the community. Furthermore, outsiders usually collect TK and genetic resources simultaneously and until the of the CBD's entry into force, genetic resources were in open access, which contributed to the impression that TK could be freely accessed.

This situation is not too problematic as long as traditional innovation is robust and contacts between communities and third parties remain limited. There had traditionally been only a limited number of outsiders accessing TK. These outsiders were typically a limited number of scientists who for most were very interested in communities' traditional ways and customs and tried to comply with them.

2.2 Mode of Knowledge Transmission

Indigenous and local communities are systems of innovation that produce, use and conserve large quantities of knowledge. Like any organization dealing with knowledge, they are faced with the challenge of transmitting knowledge between members and to the next generations. It is a difficult task because knowledge is a good that is difficult to precisely identify, to describe and to transmit. An important proportion of knowledge (know-how) is produced unconsciously in the course of the action. The capacity to identify and document these elements of knowledge is vital for any organization whether it be a traditional

community or a modern firm. Communities holding TK face the same options as any organization managing knowledge. The first strategy consists in the systematic codification of knowledge so that it is documented. In that case, it can be easily accessed and used by members of the organization. Alternatively, they can adopt a strategy of personalization in which knowledge is kept as know-how. This way it remains bound to the person who developed it, and it is transmitted by personal contacts among members within the organization. Dialogue among individuals is preferred to documented knowledge. This strategy entails important investment in the development of interpersonal networks, and a culture of mobility and personal communication within the organization. For that reason, it is essential that there are a high degree of stability in the membership of the organization and a process of training from one generation to another.⁶⁴³

It is reasonable to affirm that thus far indigenous and local communities holding TK have relied for the most on a strategy of personalization to ensure the devolution of their knowledge: retaining knowledge through oral transmission binds it to specific knowledge holders such as shamans, and if the next generation is to acquire and learn it, it must be done through apprenticeship⁶⁴⁴.

The purpose of this chapter was to examine the situation of traditional knowledge before the current discussions on its protection. The next stage consists of identifying changes that are at the origin of the demand of protection for TK.

⁶⁴³ Dominique Foray (2000), *L'économie de la connaissance*, Paris, La Découverte, pp. 47, 54, 95-96

⁶⁴⁴ On the importance of the completion of apprenticeship see for instance J.W. Hendricks (1988), "Power and Knowledge: Discourse and Ideological Transformation among the Shuar", 15 *AMERICAN ETHNOLOGIST* 216

3. Two Changes and a Demand for the Protection of TK

In the previous chapter, I described what has long been the situation for traditional knowledge, its traditional property regime and its traditional mode of transmission. In this chapter, I explain how this situation is modified by two changes. Downstream of the chain of innovation, scientists, development agencies and bio-industries show a growing interest for TK. On the upstream side of the chain of innovation (within communities), traditional knowledge is eroding. The combined effect of these two changes has led to a demand for protection of traditional knowledge.

3.1 Downstream: A Growing Interest of Outsiders for TK

Traditional knowledge was long considered little more than unscientific and superstitious practices of witch doctors or the slavish repetition of outdated farming methods by unsophisticated peasants. Scientists have long been confounded by holistic cosmologies that intertwine empirical, ecological, social and spiritual elements. However, it is progressively observed that practices that may first appear to be superstitious to the outsider actually prove to be empirically sound ways of dealing with environmental, farming, or health problems once knowledge about the environment and the culture are acquired.

3.1.1 A Growing Interest for Traditional Knowledge⁶⁴⁵

If examples of exchanges between science and traditional knowledge have always existed, there has been a growing interest for traditional knowledge during the last half century with the apparition of “ethnoscience”, a scientific approach to TK based on the work of Harold Conklin. Harold Conklin worked among the Hanuoo of the Philippines in the 1950s. Ethnoscience or cognitive anthropology is the study of people’s perceptions of their surroundings as reflected in their use of language. The taxonomies resulting from such analyses reveal categories based on locally relevant criteria. Ethnoscience enables scientists to appreciate the coherence of traditional knowledge systems, their local precision and their adaptation to their local environment. This

⁶⁴⁵ This paragraph is largely inspired by the following document which is an excellent synthesis of this issue, International Council for Science (2002), “Science, Traditional Knowledge and Sustainable Development”, ICSU SERIES ON SCIENCE FOR SUSTAINABLE DEVELOPMENT, No. 4

field of study further gave birth to a series of related disciplines such as ethnobotany, ethnopedology, ethnoforestry, ethnoveterinary medicine, and ethnoecology, which all focus on specific aspects of traditional knowledge.

During the 1970s and 1980s, ethnobotany, the study of plant uses by TK holders grew, and the interest for TK expanded beyond anthropology with the added contribution from biological systematics, structural linguistics, cognitive psychology and logic. There began a general realization that indigenous and local communities may be a potential source of information for science. At first, the interest was mainly academic and examined traditional knowledge it for its own sake.

As time went on, researchers working in **multilateral or bilateral agencies** promoting sustainable development begun to understand the usefulness of traditional knowledge for their programs on environmental conservation and agricultural productivity. For examples in the late 1980s, environmental NGOs supported by development agencies and private donators begun to develop programs for nature conservation involving local communities and relying on their knowledge and practices. In the agricultural field, the CGIAR worked increasingly closely with local communities to promote their mutual interest in sustainable agriculture.⁶⁴⁶

Finally, there was a realization that traditional knowledge was an important source of information for science and bio-industry (including the pharmaceutical, agricultural, and cosmetic sectors). This led to concern about bioprospection and the ownership of traditional knowledge.

Bio-industries' interest in traditional knowledge received very large media publicity following a few cases of TK appropriation. In each of these cases, individual scientists or firms had had access to elements of traditional knowledge and were granted a patent based on this TK without informing or obtaining the permission of the TK holders. So far, the number of these cases remains limited but the emotion they caused and the publicity they received have affected the atmosphere of the debate about TK protection, making it very tense and polemical. That is why, in the following paragraphs, I briefly describe the most famous cases. In the Ayahuesca and the Quinoa cases, patents were granted on plants, used for long by TK holders, the use for which they were

⁶⁴⁶ Mac Chapin (2005) "Le défi indigène", 75 LE COURRIER DE LA PLANETE 33

patented did not necessarily correspond to the traditional use. As for the Turmeric and the Neem cases, it was the traditional use that was patented.

3.1.2 A Few Well-Known Cases of Appropriation by Patents

Varieties of **ayahuasca** (also called yagé) have been known and used for centuries by shamans of indigenous tribes throughout the Amazon Basin in religious and healing ceremonies to diagnose and treat illnesses, meet with spirits, and divine the future. In 1986, the U.S. Patent and Trademark Office (PTO) issued Plant Patent 5,751 to Hawaiian botanist Loren Miller for a purportedly new variety of ayahuasca (*Banisteriopsis caapi*). Eight years later, the Amazonian Indians learned about the existence of the patent. They were totally stunned to discover the appropriation of their sacred plant that they had known and cultivated since time immemorial. Prolonged exchanges between a coordination of Amazonian indigenous organizations (COICA) and Loren Miller did not convince the scientist to voluntarily renounce his patent. Consequently, in 1999 the COICA and other organizations filed a challenge to the patent on the grounds that the patented variety is naturally-occurring and already in widespread medicinal use (the "prior art" exception to patentability). The PTO agreed in an Office Action dated November 3, 1999 that the patent should never have been issued. However, in January 26, 2001 the PTO reversed its decision, thus terminating the examination proceeding.⁶⁴⁷

In April 1994, a United States patent (patent number 5,304,718) was awarded to the University of Colorado for Cytoplasmic male Sterile **Quinoa**, which is in fact a hybrid of varieties grown by Aymara communities near Lake Titicaca, Peru. The Bolivian Indian quinoa producers contested the patentability of their plant and successfully used media pressure to convince the University of Colorado to let the patent lapse. Four years later, the patent was finally abandoned.⁶⁴⁸

In 1995, two U.S. based Indians were granted U.S. Patent 5,401,504 on the Use of **Turmeric** in Wound Healing. Most people in India greeted the news with disbelief and surprise because turmeric has been traditionally used in India for wound healing. The Centre for Scientific and Industrial Research, an autonomous institution under the

⁶⁴⁷ See Glenn Wiser (2001) "U.S. Patent and Trademark Office reinstates Ayahuasca Patent: Flawed Decision Declares Open Season on Resources of Indigenous Peoples", CIEL

⁶⁴⁸ See J.-A. Gari (1997) "The Role of Democracy in the Biodiversity Issue: The Case of Quinoa", Center for Latin America Research and Documentation Papers, Amsterdam

Department of Science and Technology in the Government of India, decided to file for re-examination of the patent at the United States Patent and Trademark Office. After an extensive search, thirty-two references were located, some of which were more than 100 years old, and in the languages of Sanskrit, Urdu and Hindi. The USPTO revoked the patent, stating that the claims made in the patent were obvious and anticipated, and agreeing that the use of turmeric was an old art of healing wounds.⁶⁴⁹

The **Neem** tree (*Azadirachta indica*) has been the subject of a considerable number of patents, most of the patented inventions using public domain traditional knowledge as a source. These patents aroused considerable controversy, especially in India where most of the traditional knowledge originates. Among these patents, one has been successfully challenged. In 1990, the multinational agribusiness corporation W.R. Grace of New York together with the United States Department of Agriculture filed a European Patent application with the European Patent Office (EPO) covering a method for controlling fungi on plants with the aid of hydrophobic extracted neem oil. The 1994 grant of the patent was at the origin of a large international protest campaign. In June 1995 the Green Group in the European Parliament, Dr. Vandana Shiva on behalf of the (Indian) Research Foundation for Science, Technology, and Natural Resource Policy, and the International Federation of Organic Agriculture Movements, based in Germany filed a legal opposition against the grant of this patent. The Opponents submitted evidence to the EPO that the fungicidal effect of hydrophobic extracts of neem seeds was known and used for centuries on a broad scale in India, both in Ayurvedic medicine to cure dermatological diseases, and in traditional Indian agricultural practice to protect crops from being destroyed by fungal infections. Since this traditional Indian knowledge was in public use for centuries, it would seem that the patent application in question lacked two basic statutory requirements for the grant of a European patent, namely novelty and inventive step. In 2001, the patent was revoked for lack of inventive step. In 2005, the appeal of the patent holder was dismissed.⁶⁵⁰

⁶⁴⁹ On the Turmeric case see A. Agarwal and S. Narain (1996) "Pirates in the Garden of India", NEW SCIENTIST, October 26, pp. 14-15 or Graham Dutfield (1999), "Protecting and Revitalising Traditional Ecological Knowledge: Intellectual Property Rights and Community knowledge databases in India", 6 PERSPECTIVES ON INTELLECTUAL PROPERTY 103, p. 112

⁶⁵⁰ Linda Bullard (2005) *Freeing the Free Tree: A Briefing Paper on the First legal defeat of a biopiracy patent: The Neem case*, Research Foundation for Science, Technology and Ecology, New Delhi, India International Federation of Organic Agriculture Movements

In these famous cases, three out of four patents were revoked. In each case, TK holders (helped by NGOs or other organizations) were at the origin of the revocation of the patents. It is difficult to estimate if there are many other cases of TK patenting because it is very difficult for TK holders to monitor use of their knowledge. Furthermore, to obtain the revocation of a patent is a very long and costly process. It is important to observe that in these cases, patents were revoked for patent law reasons: these patents did not fulfill the novelty and/or inventive step requirements. Patent offices had not taken into account the relevant prior art and TK holders obtained the revocation by showing their prior use of the inventions. These patents were not revoked by virtue of customary law. Thus, they do not amount to recognition of any rights TK holders may have to their knowledge.

3.1.3 Numerous Discreet Cases of Publication of TK by Scientists, Placing it in the Public Domain

Aside from the limited cases where TK has been patented by third parties, the principal means for TK leaking from communities lies in academic publication. In a survey on the use of TK by third parties, Russel Barsh⁶⁵¹ identifies only a limited number of patents derived directly from traditional knowledge. Among these patents, very few patents are based on the applicant own field research; most patents with traditional knowledge origin are inspired by data already placed in the public domain through the publication of academic researchers. By contrast, Barsh and others⁶⁵² identify countless books and academic journal articles that disseminate detailed information on the identities and traditional uses of hundreds of plants. In addition, a large proportion of these authors are from developing or transition countries, which should qualify the North-South tension in the discussions on TK protection.

To some extent, publication of ethnobotanical knowledge may help to validate and legitimize traditional knowledge systems. On the other hand, publication of traditional knowledge without the prior informed consent of its holders might infringe the rights of the latter. TK holders not only

The Greens/European Free Alliance in the European Parliament, available at http://www.ifoam.org/press/press/pdfs/Briefing_Neem.pdf

⁶⁵¹ Russel L. Barsh (2001), "Who Steals Indigenous Knowledge", 95 Am. Soc'y Int'l L. Proc. 153

⁶⁵² See for instance William Milliken (2002), "Peoples, Plants and Publishing" in Sarah Laird (ed.), *Biodiversity and Traditional Knowledge: Equitable Partnerships in Practice*, London: Earthscan, p. 79

complain about the appropriation of their knowledge by third parties through IPRs, they also reject the application of notions such as public domain or research exceptions, or the distinction between disclosed and undisclosed knowledge to their traditional knowledge. They consider that these notions, which come from formal intellectual property law, conflict with the provisions of their customary intellectual property law. Whether elements of knowledge belong to individual members of the community or to the whole community, it is rare that members (or *a fortiori* outsiders) have the right to use knowledge in a free and unconstrained manner. The customary law of the community binds them.⁶⁵³

3.2 Upstream: Erosion of Traditional Knowledge

The state of traditional knowledge is somewhat paradoxical. While its value increases as scientists show a growing interest for it as a source of information for their research, TK is eroding and its existence is threatened by a multitude of reasons.

A first series of threats concerns the economic and political conditions of local and indigenous communities. The most important threat to traditional knowledge might well be the rampant poverty of indigenous and local communities. Pressures of poverty place great strain on the communities' organization and their ability to maintain their way of living. Poverty is also the reason why indigenous peoples leave traditional lands and move into urban centers. This has been identified as a major obstacle to the transmission of TK: younger segments of the population who should receive transmission of TK leave the communities to find work elsewhere.⁶⁵⁴ A related threat to the preservation of traditional knowledge lies in the lack of land security for indigenous and local communities. The notions of collective rights to land and the nature of the relationship of these communities with their land are not correctly addressed in modern forms of land ownership. In the past and to some extent still today, alienation from traditional territories continues to

⁶⁵³ Tulalip Tribes (2003) *Statement by the Tulalip Tribes of Washington on Folklore, Indigenous Knowledge, and the Public Domain*, July 09 at the Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore, Fifth session, Geneva, July 5-17. See also Colin Golvan (1998), "Aboriginal Art and the Public Domain" 9 JOURNAL OF LAW AND INFORMATION SCIENCE 122

⁶⁵⁴ CBD (2005) *The Revised Phase One and Phase Two of the Composite Report on the Status and Trends Regarding the Knowledge, Innovations and Practices of Indigenous and Local Communities Relevant for the Conservation and Sustainable Use of Biological and Sustainable Use of Biological Diversity: Executive Summary and Recommendations*, UNEP/CBD/WG8J/4/4, p. 22 hereafter CBD (2005) *The Status and Trends of TK...*

occur. If some progress has been made recently in land security, regularization of communities' ownership and titling processes have not been completed in most countries.⁶⁵⁵ Lastly, education policies are viewed as both a major obstacle to TK retention and transmission and simultaneously as a possible solution. The reason why education policies were often an obstacle to TK transmission is that they were used to assimilate indigenous children and alienate them from their communities. However, today education systems with programs designed in collaboration with local and indigenous communities incorporate traditional knowledge and are regarded as a measure to possibly assist in its use and its transmission⁶⁵⁶.

A second series of threats to traditional knowledge concerns the degradation of the environment and the erosion of biodiversity. Because TK holders live in close connection with their environment and have developed knowledge specific to their immediate environment, they are among the first victims of environmental degradation as TK is subject to the same threats as biodiversity. TK is subject to the conversion process, which turns natural uses of land into other uses that are more immediately valuable in the modern economy. The survival of local and traditional communities has been largely due to their relative geographic and economic isolation in territories that were long regarded as inaccessible or worthless. As a result they often live in undisturbed lands that are reservoirs of biodiversity. However, nowadays these lands are regarded as interesting places for the exploitation of natural resources such as extractive industries, including logging or deforestation for agriculture. When the communities are otherwise not simply removed from their lands, these activities damage their environment⁶⁵⁷. Similarly, traditional knowledge is also subject to the process of specialization in agriculture. The modernization of agriculture, often referred to as the "green revolution" (Cf. *Part Two*), conducted traditional farmers to abandon thousands of traditional varieties in favor of a handful of modern high-yield varieties. In addition, this modernization modified the organization of land use and displaced millions of traditional farmers in

⁶⁵⁵ *Ibidem*, p. 17 and 20

⁶⁵⁶ *Ibidem*, pp. 13-14, see also the International Labour Organisation (ILO) Convention (No. 169) *Concerning Indigenous and Tribal Peoples in Independent Countries* adopted on 27 June 1989 by the General Conference of the ILO at its seventy-sixth session, especially part four.

⁶⁵⁷ Russel L. Barsh (1999) "The World's Indigenous Peoples", Paper submitted to Calvert Group by First Nations Development Institute/First Peoples Worldwide Available online at <http://www.calvertgroup.com/investor/ind-sri-about-ip-policy-barsh.html>

Asia and Latin America. Displacements and changes in land uses and crop varieties have made important aspects of traditional knowledge irrelevant for its holders. Lastly, biodiversity conservation policies have had an ambiguous effect on traditional knowledge. While some conservation programs try to lean on traditional knowledge and local management of natural resources by indigenous and local communities⁶⁵⁸, many conservation policies exclude these communities from their considerations, preferring the creation of protected areas whose access is prohibited and thereby alienating them from their lands.⁶⁵⁹

3.3 A Demand for the Protection for TK

I have just explained that TK is the subject of two phenomena: on the one hand there is a growing scientific interest for it; on the other hand it is threatened by serious erosion. Observed from the standpoint of TK holders or from the point of view of the international community, these two trends suggest the creation or the recognition of intellectual property rights to traditional knowledge.

First, as I have already explained in the previous parts of this dissertation, the theory of property rights developed by Demsetz and others⁶⁶⁰, predicts that the creation and the enforcement of property rights is primarily a function of changes in value. When the value of a good rises, potential owners will attempt to convince governments or courts to change property laws in order to allow the capture of the new value. The growing interest of scientists and later biodiversity conservationists and bio-industry for traditional knowledge, gives TK holders the impression that their knowledge is no longer worthless for outsiders but rather a valuable resource. TK holders have begun to realize the two functions of traditional innovation. Traditional knowledge is not only useful and vital for the daily life of TK holders; it is also a valuable source of information for science and bio-industry

⁶⁵⁸ Thomas O. McShane (2003), "The Devil in the Detail of Biodiversity Conservation", 17 CONSERVATION BIOLOGY 1

⁶⁵⁹ Mac Chapin (2005) "Le défi indigène", LE COURRIER DE LA PLANETE, n° 75, p. 33, and CBD (2005) *The Status and Trends of TK...*

⁶⁶⁰ Harold Demsetz (1967), "Towards a Theory of Property Rights" 57 AMERICAN ECONOMIC REVIEW 347; Thrainn Eggertsson (1990) *Economic Behavior and Institutions*, Cambridge: Cambridge University Press; Douglas C. North (1990), *Institutions, Institutional Change and Economic Performance*, Cambridge: Cambridge University Press; Yoram Barzel (1997) *The Economic Analysis of Property Rights*, Cambridge: Cambridge University Press

R&D. The prospect of appropriating a part of the rent provided by biotechnological inventions incites TK holders to claim compensation for the use of their knowledge and respect by users of their customary rights on TK. This demand is strengthened by a feeling among TK holders of an asymmetry in the treatment given by formal intellectual property law to their knowledge as opposed to other forms of knowledge. This includes bio-industries' knowledge, as bio-industry can patent their knowledge whereas TK is deemed to be in the public domain. As a result, TK holders have enounced a series of claims that can be summarized as follows⁶⁶¹ TK holders would like:

1. to be identified as authors or inventors of their knowledge.
2. to be able to control access to their knowledge.
3. to be compensated for the use of their knowledge.
4. to preserve their cultural identity.
5. to preserve the organizational structure that enables the continuous production, use and conservation of their knowledge.

These claims can be divided into two groups. The first group includes the first three claims that are directly related to intellectual property protection. The second set of claims includes the two last demands; they are more loosely related to intellectual property though they concern the conditions that produce TK innovation. Often, TK holders, notably indigenous peoples, use a different vocabulary and ask for the respect of their customary law in a broader claim of self-determination. It is worth looking at this second set of claims in order to account for the conditions producing TK innovations.

The second phenomenon is discussed in light of the theory of property rights developed by Ronald Coase. Coase predicts that problems of externalities and public goods can be solved by the creation of property rights. The conservation of traditional knowledge and its continuous updates appears now to be a public good or at least as a source of positive externalities⁶⁶². Traditional knowledge is not only useful for its producers but also for the international community as it is a useful source of information for bio-industry or an instrument for conservation policies. If TK holders cannot capture the benefits of conserving and

⁶⁶¹ Ruth L. Okediji (2002), "Making Room at the Table: The Protection of Indigenous Knowledge at the Interstices of International Law, Human Rights and Intellectual Property", in CILP, Lecture Series Pub., University of Toronto. Hereafter "Making Room at the Table..."

⁶⁶² Later, I will qualify the public good characteristics of traditional knowledge (*Cf. chapter 5*)

producing traditional knowledge they will under-invest in the conservation of their knowledge and young generations will continue to abandon traditional ways of life and traditional knowledge. One possible solution lies in the creation of intellectual property rights enabling TK holders to internalize the benefits of conservation.

There is, therefore, some convergence in favor of the creation of property rights (or other instruments) to protect traditional knowledge. The Convention on Biological Diversity (CBD), which entered into force in December 2003, calls for the protection of TK. This assertion of protection for TK in article 8J, however, is more of a political concept assigning objectives to states rather than a clear property right for TK. Therefore, there is need for further (legal) action at international and/or national levels to implement the intention behind article 8J.

Before examining current efforts to protect traditional knowledge, I believe it is useful to highlight some difficulties that any attempt to conserve TK and enhance its use will have to take into account.

4. Difficulties in Protecting Traditional Knowledge

In this chapter I would like to stress four issues that must be taken into account in researching the best means to conserve and further use traditional knowledge. The first two issues relate to the nature of traditional knowledge and the fragility of its mode of transmission that hinder both (1) the use of TK by outsiders and (2) its maintenance by its holders. These issues concern the different levels of regulation of traditional knowledge: local and international.

4.1 Difficulties in Transferring TK

TK holders and the international community examine the possibility of designing and granting property rights to TK, not only to enable TK holders to prevent third parties to access their knowledge but also to enable them to transfer and exchange it for compensation. However, an important difficulty comes from the nature of traditional knowledge: a large part of TK fits into the definition of tacit knowledge, or can be assimilated to tacit knowledge, which hinders its transfer.

Tacit knowledge refers to particular know-how or undeveloped ideas that are best communicated through personal communications. Often the holder is only partly aware that he owns tacit knowledge. Well-known examples of tacit knowledge include where a rugby player has a technique for scoring a try, but is only partly aware of what he does and is unable to describe it in a way that easily allows someone else to reproduce his gestures.⁶⁶³ Actually, the same is true for much knowledge involved in the innovation process, especially in the field of biotechnology. Tacit knowledge is the opposite of codified knowledge. Codification of knowledge is the process by which knowledge is converted into a message that can be processed as information. Codification liberates knowledge from its attachment to the person who had incorporated the tacit knowledge. Codified knowledge is therefore more like a commodity⁶⁶⁴.

⁶⁶³ P.A. Mangolte (1997), « La dynamique des connaissances tacites et articulées : une approche socio-cognitive », *ECONOMIE APPLIQUEE*, Tome L.2

⁶⁶⁴ Dominique Foray (2000), *L'économie de la connaissance*, Paris, La Découverte, p. 48

Part of TK consists of tacit knowledge. More broadly, an important part of TK can be assimilated to tacit knowledge because it is very difficult to transmit it outside the community of knowledge holders. Most of TK is orally transmitted. It is often unsystematically conserved or conserved with a classification that does not correspond to those used in modern science. It is sometimes mixed with magic formula –often used as a smoke screen meant to control the diffusion of knowledge. Finally, yet importantly, it is often expressed in languages with a limited number of speakers. Therefore, the actual or potential contribution of TK to bio-industries R&D can reasonably be assimilated to tacit knowledge. The tacit character of TK is probably one of the major obstacles to its further use in R&D.

The tacit character of knowledge hinders a series of operations. The exchange, the diffusion, and the learning of tacit knowledge require the displacement and the voluntary demonstration of knowledge holders. These operations are costly and difficult to implement. The storage and the memorization of tacit knowledge are conditioned by the permanent renewal of peoples holding this knowledge. Finally, the tacit character of knowledge slows down the cumulativeness of innovation. The identification of complementary pieces of knowledge and their holders is limited by it being tacit and this impedes systematic identification and classification.⁶⁶⁵

4.2 Difficulties in Conserving and Transmitting TK

In addition to the difficulty of transferring and sharing traditional knowledge with third parties, the existence of traditional knowledge is also affected by its mode of transmission. In the previous chapter, I explained that any organization dealing with large quantities of knowledge might choose to combine two transmission strategies: a strategy of codification or a strategy of personalization. So far, indigenous and local communities holding TK have, for the most part, relied on a strategy of personalization to ensure the transmission of their knowledge. An important proportion of knowledge remains oral; it is exchanged by interpersonal exchanges and transmitted to the next generation by a long process of apprenticeship. The success of this strategy of transmission depends on the stability in the membership of the organization and the constantly renewed training process.

⁶⁶⁵ *Ibidem*, pp. 47 and 71

The major problem is that for many communities this strategy of transmission is in a deep crisis.⁶⁶⁶ Without going too deep in to this issue, it is observed that the poverty of indigenous and local communities and destruction of their environment causes the younger generations to move to urban centers. This hinders the transmission of TK because younger working age sections of the population, who should be receiving traditional knowledge, leave the communities. More broadly, as modernization spreads over the world, young peoples seem unable to recognize value in traditional ways and they do not perceive any potential economic return from engaging in traditional activities. As an illustration, Lee *et al.* report that “*traditional leaders in Micronesia were concerned that [...] over the last two generations a large percentage of traditions and skills specific to Micronesia have not been passed on, and will become extinct if an active program is not put into place to keep them an active part of local life.*”⁶⁶⁷ Even the existence of language is threatened. Nettle and Romaine point out that of the 6600 languages spoken today, fewer than nine percent, or 600 have enough speakers to ensure their continuity into the next century. This loss of language includes ninety percent of the 250 Aboriginal languages in Australia near extinction with only eighteen having at least 500 speakers each. They also note that no children are learning any of the 100 native languages spoken in the state of California.⁶⁶⁸ Also, the devolution of TK from one generation to the next is less and less effective.

4.3 Erosion of Customary IP Law

The erosion of the customary law is another difficulty in the protection of traditional knowledge. Within communities, customary laws or social

⁶⁶⁶ As an illustration, in a description of a bioprospecting project, the authors write: “*The botanical knowledge of the Maroon people is rapidly disappearing as young people move away in search of work and the population becomes more dependent on western medicine. In many ways, the Suriname ICBG project is a race against time to record the hundreds of years of medicinal learning that is stored in the minds of shamans, some of whom are more than 80 years old. [...] The importance of these objectives was starkly reinforced when one of the original eight shamans to participate in the project died after working with a collection team for only a week. With no written record of his knowledge and no apprentice, this knowledge died with him.*” Marianne Guérin-McManus *et al.* (1998) *Bioprospecting in Practice: A Case Study of the Suriname ICBG Project and Benefits Sharing under the Convention on Biological Diversity*, Submission to the Executive Secretary of the Convention on Biological Diversity available on the website of the Secretariat at <http://www.biodiv.org/doc/case-studies/default.asp>

⁶⁶⁷ R Lee, M.J. Balick, D.L. Ling, F. Sohl, B.J. Brosi, W. Raynor (2001), “Cultural dynamism and change—an Example from the Federated States of Micronesia” 55 *ECONOMIC BOTANY* 9-13

⁶⁶⁸ D Nettle and S. Romaine (2000), *Vanishing Voices: the Extinction of the World's Languages*, Oxford: Oxford Press

norms define informal property rights to elements of TK and the rules of knowledge exchange. These laws and norms are essential to the continuation of traditional innovation. The erosion of customary law is notably due to the poor social and political conditions of traditional communities and the degradation of their environment that affect their organization. Also, the maintenance of informal regulation becomes much more delicate when outsiders' interest for accessing traditional knowledge grows or when the institutional environment –the CBD and patent law – favors the appropriation of TK or research results. In this light, norms and the institutional environment may become (partly) antagonist.

The difficulty can be divided into two issues. The first issue, which can be referred as **external defection**, is to enforce social norms or customary law against third parties. Indeed, non-members of a community have no incentive to respect the norms and customs of the community. Firms have no interest in complying with the norms of science and renouncing to patent basic research. Firms also have no interest in renouncing patented inventions derived from traditional knowledge. Social norms and customs are sanctioned by informal sanctions ranging from loss of reputation, to ostracism or even expulsion from the community but these sanctions cannot be imposed or have little impact on non-members.

The second issue is the necessity to preserve capacity of a community to organize innovation against **internal defection**. Indeed, the effectiveness of social norms or customary law within communities might be threatened⁶⁶⁹. The CBD regime requiring exclusive rights may create incentives that run counter to customary law. Outsiders' interest in accessing TK and the possibility of selling access or even obtaining IPRs changes the incentive structure that makes individuals comply with customary law. Even if a member of a community strongly believes that he should respect customary law, and that only the community authorities are entitled to grant access to TK, the payoff to breach customary law and negotiate personal compensation for divulging TK might be high enough to make him hesitate⁶⁷⁰. In addition, if a member

⁶⁶⁹ For illustration see Paul Kuruk (1999), "Protecting Folklore ..."

⁶⁷⁰ Following Douglas C. North, I assume that the trade-off between wealth and those other values is a negatively sloped function. That is, where the price of expressing one's values is low / high, they will account much more/ less for human behavior. See North (1991) *Institutions, Institutional Change and Economic Performance*, Cambridge University Press (see chapter 3 on behavioral assumptions). This situation could be also analyzed as a prisoner dilemma.

concludes that other members of the community could also be tempted to breach customary law, he may be further induced to breach customary law to be sure he secures the benefits.

4.4 The International Dimension

When discussing the best form of protection for traditional knowledge, it is important to keep in mind the international dimension. Protecting someone's invention or knowledge in foreign countries has always been a delicate issue in all domains of intellectual property. It is even more essential for TK because in many cases TK holders and potential users are not in the same country.

If we assume that an IPR or some *sui generis* right protects TK in the country of origin, then we must ask what kind of protection can be expected abroad by TK holders. In a brief analysis, one must distinguish several scenarios which take different criteria into account: : first, whether a similar right is available in the user's country; second, whether TK is accessed in the country of origin or in the user's country; third, one must be aware of the difference between property rights and contractual rights.

- If there is no similar IPRs available in the user's country and if the protected traditional knowledge is accessed in the user's country, then use, copy or counterfeit of that TK are legal and TK holders have no remedy.
- If there is no similar IPRs available in the user's country and if protected TK is legally accessed in the country of origin (with TK holders' consent) but the conditions of access are later violated in the user's country, then TK holders only have a contractual right against the co-contracting parties while they have no right vis-à-vis third parties.
- If similar IPRs are available both in the countries of origin and in the user's country (and if knowledge holders have been granted rights in both countries), the situation is very different. Rights holders have a property right, and they can enforce the right they have been granted in the user's country against any infringer whether co-contractor or third party. As an illustration, let us consider a body of traditional knowledge that can be patented. Patents are available in almost all countries. If TK holders have been granted a patent in those countries, they can enforce their patent against any infringer.

- Theoretically, one could imagine a scenario where different countries grant different kinds of rights on TK and where TK holders apply for the protection available in each country. However, it will be very costly and complicated to apply for those IPRs and monitor the use of TK in the different countries.

How does intellectual property law take into account right holders' need for international protection? First, it must be recalled that intellectual property is essentially protected through rights recognized and exercised under national laws. It is under national law that IPRs are legally recognized. It is also at the national level that rights holders are entitled to be granted a right and that they are given recognized legal personality. It is under national legal mechanisms that IPR holders can take action against infringement of their rights and seek remedies. Validity of any IPR in one country is not dependent on its validity elsewhere. Finally, contracts that affect IPRs are also concluded and enforced under national laws.⁶⁷¹

However, since the conclusion in the late nineteenth century of multilateral treaties⁶⁷² like the Paris Convention for the Protection of Industrial Property in the Berne Convention for the Protection of Literary and Artistic Works, international intellectual property law has included some legal principles that allow non-discriminatory access to the intellectual property systems for foreign rights holders. The principle of **national treatment** requires a state to grant the same rights to foreign rights holders that it grants to its nationals. Under the **most favored nation** provision, any advantage granted by a state to the national of any other country must be accorded immediately and unconditionally to the nationals of all member countries. Both these principles have an equalizing or an assimilation effect but they do not in and of themselves provide a harmonizing effect. Under the principle of **reciprocity**, state A agrees to grant IPRs to citizens of state B if state B agreed to grant IPRs to citizens of state A. This principle may sometimes be at the origin of an international standard when there is a hegemonic actor, a convergence of interest and a limited number of interested countries. As an illustration, the US enacted *sui generis* legislation for integrated

⁶⁷¹ See WIPO (2003) *Traditional Knowledge, Traditional Cultural Expressions, and Genetic Resources: The International Dimension*, WIPO/GRTKF/IC/6/6

⁶⁷² Actually, the international dimension of intellectual property was first faced in the mid-nineteenth century with a series of bilateral trade agreements including provisions on intellectual property.

circuits⁶⁷³ and access to protection for foreign citizens was conditioned by reciprocity. This convinced Japan and European countries to join the US and negotiate the Washington Treaty on Intellectual Property in Respect of Integrated Circuits. However, those conditions do not seem to be present for TK protection. Last, the principle of **mutual recognition** allows the recognition of another state's standards of protection. It requires a state to recognize the standards of protection of other states. However, states may be reluctant to commit themselves to such principles for fear of the non-reciprocal effect. For instance, if country A is providing strong TK protection and country B is providing no protection, under a principle of mutual recognition rights holders of country A could protect their TK in both countries and rights holders of country B could protect their TK in neither of the two countries. Therefore, mutual recognition requires some international standards of protection.⁶⁷⁴

These four principles on the recognition of foreign rights holders may play an important role in the international protection of TK. However, whether or not these principles apply, an effective protection regime requires some international standards of protection. In the more recent history of intellectual property, there has been a move towards substantive minimum standards. Later revisions of the Paris and the Bern Conventions and the WIPO Copyright Treaty include some substantive standards that determine the rights and exceptions to rights available under national legislation.

Last, the negotiation of an international treaty does not create in and of itself binding law. Ratification can be low or very limited, like for the Vienna Convention on the protection of Type Faces and the Geneva Convention on the Recording of Scientific Discoveries, which failed to enter into force for lack of ratification. Recently, the TRIPS Agreement played a major role in generalizing the standards of protection of the Paris and Bern Convention (and some new ones) to all of the WTO members.⁶⁷⁵

⁶⁷³ The Semiconductor Chip Protection Act (SCPA) of 08/11/1984, Title 17 USC (ch.9) §§ 901-914

⁶⁷⁴ Peter Drahos (2004), "Towards an International Framework for the Protection of Traditional Group Knowledge and Practice", UNCTAD-Commonwealth Secretariat Workshop on Elements of National *sui Generis* Systems for the Preservation, Protection and Promotion of Traditional Knowledge, Innovations and Practices and Options for an international Framework, Geneva, 4-6 February

⁶⁷⁵ To be complete, international dimension of intellectual property may also include other elements such as international notification and registration system, or

If TK holders and the international community want to offer international protection for traditional knowledge, they need to define international standards of protection. This has two consequences for TK protection. First, national legislation enacting *sui generis* rights⁶⁷⁶ are very valuable in testing new instruments of protection and contributing to the discussion, but they have a limited effect, as they do not apply outside national territory. Second, there are two main options for TK holders to obtain international protection: either they resort to an existing system of IPRs with international standards of protection or they promote the adoption of new international standards (an international *sui generis* right) in a widely ratified international treaty.

In this chapter, I have emphasized four dimensions of TK protection that should always be present in the search for protection mechanisms. I will now examine how we could define property rights to encompass traditional knowledge.

administrative cooperation on issues like classification and documentation standards, or also collective management of IPRS.

⁶⁷⁶ For analyses of national policies and legislations on TK protection, see the documents of the WIPO-IGC, notably WIPO (2003) *Information on National Experiences with the Intellectual Property Protection of Traditional Knowledge*, WIPO/GRTKF/IC/5/INF/2, and WIPO (2003) *Comparative Summary of Existing National Sui Generis Measures and Laws for the Protection of Traditional Knowledge*, WIPO/GRTKF/IC/5/INF/4.

5. Defining Property Rights on TK

In this chapter, keeping in mind the four issues stressed in Chapter Four, I analyze the current attempts to protect traditional knowledge and to define property rights. I start with a description of the ongoing discussions within the World Intellectual Property Organization, I then identify and explain some of the limits of the considered solutions. In the second section I examine examples of practical experiences in the protection of TK. In the third section I suggest a justification for the protection of TK and look at how it could provide guidance on the design of effective solutions. In the last section, I try to combine the lessons of practical experiences with theoretical justification in order to analyze the contribution of databases to the protection of traditional knowledge.

5.1 The Current Debate on Traditional Knowledge Protection

At the national level, some states have enacted *sui generis* legislation in an attempt to implement article 8J.⁶⁷⁷ Some of these national laws contain provisions for the creation of TK registries. These legislative provisions could provide a model for an international regime. For now, however, the effect of these national laws is limited by the fact that they only apply within the territory of their respective state. Therefore, attention is focused on the international discussions regarding a possible common standard for protection of traditional knowledge.

5.1.1 International Discussions and the Notion of Misappropriation

At the international level, the most dynamic forum on TK protection is the Intergovernmental Committee on Intellectual Property, Genetic Resources, Traditional Knowledge and Folklore of the World Intellectual Property Organization (WIPO-IGC). This committee is in charge of preparing guidelines, model laws and/or an international treaty on the protection of TK. Through reading the WIPO-IGC documents with a view towards the design of a protection regime, it appears that the notion of “misappropriation” acts as an organizing principle and to some extent a justification for the protection of TK

⁶⁷⁷ See WIPO (2003) Comparative Summary of Existing National Sui Generis Measures and Laws for the Protection of Traditional Knowledge WIPO/GRTKF/IC/5/INF/4

There appears to be a large consensus on the objectives of protection. Preventing misappropriation involves both defensive protection, i.e. preventing the acquisition of intellectual property rights over TK by parties other than customary TK holders, and positive protection, i.e. providing legal means to enable TK holders to restrain third parties from unauthorized uses of protected material, and to empower TK holders to negotiate for compensation if and when unauthorized acts occur. Thus, the objectives of protection drafted by WIPO-IGC correspond to the first set of claims of TK holders.

However, there is much less clarity and consensus on the design of the protection mechanism. Document GRTKF/IC/8/5 of the WIPO-IGC, entitled “*Protection of Traditional Knowledge: Revised objectives and Principles*”, mentions broad rights but poorly defines them.

The “*subject of protection*” is defined in a comprehensive but vague manner. Article 3 on the “General Scope of Subject Matter” provides a useful definition of TK and states that protection should not be limited to any technical field. Article 4 on the “Eligibility for Protection” establishes the traditional character of knowledge as the requirement for its protection. Knowledge must come from a traditional context, be associated with a traditional or indigenous community, and be part of the cultural identity of this community. However, if the traditional character of knowledge is to be selected as a criterion for protection, one must explain how to verify that the conditions for protection are met, who will undertake the verification, whether there will be an *ex ante* (like in the case of patents) or an *ex post* examination during which TK custodians will claim that part of their knowledge has been misappropriated, and whether there will be a system to notify third parties which knowledge is protected (e.g. a registration system). In addition, identifying knowledge by its traditional character comes down to identifying the subject matter for protection by its right-holding beneficiaries. This may lead to confusion between two different questions, i.e. the requirements for protection and identification of the rights holder. The problem is further complicated by the fact that the next article identifies the beneficiaries of protection as TK holders. As such, the definition appears to be somewhat circular: the subject of protection is defined by its beneficiaries and the beneficiaries are identified by the subject of protection and none of them is defined independently.⁶⁷⁸

⁶⁷⁸ It could be argued that this is also the case in other sectors of intellectual property law. For instance, in patent law, the object of protection is an invention and the

Furthermore, beneficiaries are comprehensively but vaguely identified. Article 5, “*Beneficiaries of Protection*” identifies beneficiaries as the holders of knowledge in accordance with the relationship described under Article 4 on the eligibility of protection. The relationship between peoples and knowledge is essential in identifying beneficiaries of protection. However, further precision is needed to make the system of protection work. In addition, as I mentioned in the previous paragraph, there is a problem of the circular definition between the provision on the eligibility of protection and the provision on the beneficiaries of protection.

Regarding the content of protection itself, WIPO-IGC documents mention a series of contract, tort and property rights but these rights already exist and are poorly defined.

Article 1 mentions the possibility of protecting TK through contract law. This has little value as TK holders currently can and sometimes do negotiate access to their TK by means of contract, usually in the broader context of a bioprospecting contract. In addition, there are some serious difficulties in contracting over TK subject matter. The first difficulty in contracting over TK subject matter arises from the characteristics of knowledge as an economic good (public good). It is difficult to control access to knowledge in the absence of a property right. If TK holders do not have the legal right to prevent third parties from accessing their subject matter, the ability to contract is of little use. Similarly, knowledge is difficult to show to a potential buyer. A potential buyer may need to see the knowledge to decide whether he wants to buy it. Once the knowledge is seen, however, there is no incentive to buy it unless there is a property right. The second obstacle derives from a limitation of contract: contracts only rule relations among contracting parties; they usually have no effect on third parties. By contrast, property rights are opposable against the world (*erga omnes*). The third difficulty is inherent in the nature of TK. For the most part, TK can be regarded as tacit knowledge. Tacit knowledge is difficult to transfer, value, identify and delineate which makes it very difficult to form the basis of a contract (*Cf.* Chapter Four).

beneficiary of the right is the inventor. However, the situation is different in patent law. Protection requirements identify what is eligible for protection. For each individual patent, the patentee's claims identify the scope of protection; the examination process decides whether the invention is protected or not and provides a kind of registration and evidence of the right. Patent law therefore includes mechanisms to identify the object of protection.

Article 1 also envisages the use of tort law to protect TK. For the purposes of illustration, this Article enumerates a long list of torts that could be invoked by TK holders. The most notable are unjust enrichment, public order and morality, and unfair competition. Once again, these mechanisms for protection are already legally available. In addition, protection by tort law depends on there being an unauthorized use of knowledge that causes actual damage. The TK holder will only receive protection (i.e. a remedy) if the use of the knowledge resulted in an identifiable damage. Moreover, those torts are outlined in a vague manner and as such it is difficult to foresee the level of protection intended before going to court and obtaining a judgement. The tort of unfair competition may be a bit more precisely drafted than the others, but it is only relevant in a limited number of circumstances. In general, unfair competition is a tort providing a remedy for the loss of market share or commercial reputation in the sale of knowledge goods. There are, however, variations in national understandings of unfair competition law. TK holders may acquire goodwill as producers of medicinal preparations, cosmetic products, or cultural products and they may suffer harm to their commercial reputation or market share by unauthorized uses of their TK. However, this hypothesis only concerns a limited proportion of TK and may apply more to cultural products such as craft or folklore.⁶⁷⁹ Therefore, it seems unlikely that unfair competition law can provide strong protection to TK holders.⁶⁸⁰

Article 1 also contains an reference to a property right by recalling the principle according to which TK cannot be accessed by third parties without the prior informed consent of its holders. However, there is no more precision of this property right.

In total, I am afraid that misappropriation as currently described in the WIPO-IGC documents is merely a set of badly defined rights likely to result in high transaction costs.

5.1.2 Limits of Misappropriation: Rights Poorly Defined and High Transaction Costs

From the standpoint of a TK holder, misappropriation offers comprehensive, affordable and easily accessible protection because there

⁶⁷⁹ Agnes Lucas-Schloetter (2004), "Folklore" (Part III, Section 4) in Silke von Lewinski (ed.), *Indigenous Heritage and Intellectual Property –Genetic Resources, Traditional Knowledge and Folklore*, The Hague, London and New York: Kluwer Law International, p. 314

⁶⁸⁰ In the circumstances in which TK could be protected by unfair competition, it might be more interesting for TK holders to consider the protection offered by trademark and geographical indication.

is no requirement for protection. Unfortunately, it will be hard to enforce such a vague right over such a vaguely defined subject matter. It will be difficult to monitor all possible violations as they are likely to occur simply because third parties do not know what is protected and the identity of the right holder. Similarly, TK holders wanting to enforce their rights will have to go to court in the country where TK is accessed. It will be difficult and expensive for TK holders to provide evidence of their rights and of their violation. Therefore, the protection offered by misappropriation seems rather costly and inefficient; indeed it often might not be economically worthwhile to enforce a right under this claim.

From a potential user's point of view, there is the risk of very high transaction costs. It may prove difficult to identify the TK rights holder who has the authorization to give access to the TK in question. As it stands, the rights of TK holders are uncertain and badly delineated. In other words, potential users will face legal uncertainty that will act as a disincentive to use TK.

In sum, misappropriation as described in WIPO-IGC documents neither prevents the unauthorized use of TK, nor encourages its use when it is the desire and goal of TK holders and users.

5.1.3 Limits of Rights-Based Justifications

One explanation for the difficulty involved in designing clear rights to TK may come from the justification of those rights. The concept of misappropriation does not only include the notion that TK holders should have a right to be protected against acts which violate the principles of equity and fairness, but it also contains, more or less explicitly, a justification for a protection regime for TK. Indeed, the concept of misappropriation echoes academic and NGO literature that justifies the need for a protection regime on the basis of natural, moral or human rights (hereinafter "rights-based justifications").

Rights-based justifications for intellectual property are loosely derived from the labor theory originating in the writings of John Locke, or the personality theory inspired by the works of Kant and Hegel. According to the labor theory, a person who labors upon resources that are "held in common" has a natural property right to the fruits of his or her efforts – and the state has a duty to respect and enforce that natural right. As facts and concepts, the raw material of intellectual property, seem to be held in common, the labor theory is widely thought to be especially applicable

to the field of intellectual property.⁶⁸¹ As for the personality theory, it suggests that private property rights are crucial to the satisfaction of some fundamental human need. They should be created in the fashion that best enables people to fulfill those needs. In that perspective, intellectual property rights are justified as a protection against appropriation or modification of artifacts regarded as a vessel for the personality of authors, artists and inventors,⁶⁸² or in the case of TK, the vessel for the cultural heritage of communities.

Similar arguments are also phrased in terms of human rights, notably with a reference to article 27.2 of the Universal Declaration of Human Rights, which provides that “everyone has the right to the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author”.⁶⁸³ Arguments based on human rights, the labor theory or the personality theory are often mixed, that is why they are sometimes collectively referred to as rights-based theories as opposed to utilitarian justifications.

The numerous advocates of rights-based justifications observe that there seems to be a growing consensus that there is something wrong with the use and appropriation of TK without prior permission and compensation of TK. The strength of such justifications can be observed in the fact that TK protection is now discussed in many international forums, and the World Intellectual Property Organization (WIPO) is considering the negotiation of an international agreement. However, if rights-based justifications play an important role in convincing people of the need for a protection regime, they do not lend themselves so easily to designing the precise content of such a regime. These moral justifications do not take into account the conditions of use of knowledge and the effect of the protection regime on the production and diffusion of knowledge. Therefore rights-based justifications are of limited help to create effective, customized and transferable property rights. They do not provide criteria that are sufficiently precise to identify the subject of

⁶⁸¹ William Fisher III (2001) “Theories of intellectual property”, in Stephen Munzer (ed.), *New Essays in the Legal and Political Theory of Property*, Cambridge Studies in Philosophy and Law. See also Peter Drahos (1996), *A Philosophy of Intellectual Property*, Burlington: Ashgate

⁶⁸² *Ibidem*

⁶⁸³ Universal Declaration of Human Rights adopted and proclaimed by the United Nations General Assembly resolution 217 A (III) of 10 December 1948

protection, the form, the scope of protection, or the beneficiaries of the rights.⁶⁸⁴

The limits of misappropriation as a protection mechanism and as a justification for such mechanisms suggest that there is a need to complement article 8J of the CBD and misappropriation with rights that are better defined and easier to trade. From that perspective it might be worthwhile to complement the rights-based justification of TK protection with a utilitarian justification. Utilitarian justifications are the dominant justification for intellectual property, though they are curiously absent from the debate on TK protection (*Cf.* section 5.3). I would first, like to take a look at how TK holders currently attempt to protect their knowledge.

5.2 How to Protect TK: The Lessons of Practice

In this dissertation, I cannot look at all attempts to protect all categories of TK. In the following paragraphs, I look at one practical attempt to protect TK: the creation of databases or registers as a mechanism for the protection of ethnobotanical TK.

5.2.1 TK Databases and Defensive Protection

Documentation of TK and the subsequent creation of databases has been done by academics for a long time⁶⁸⁵ and by some TK holders since the mid 1980s. However, it is the patenting by corporations of inventions derived from TK (*Cf.* section 3.2) that initiated a larger movement to document and create TK databases as instruments for defensive protection. TK holders realized that third parties could obtain patents derived from their knowledge because TK was not sufficiently taken into account by patent offices when assessing the novelty, non-obviousness, and inventiveness requirements for obtaining a patent. In practical terms, patent offices reviewing prior art had difficulties in accessing TK that was not widely known and often orally transmitted. In addition, under American Patent law (not under European patent laws), prior art

⁶⁸⁴ Padmashree Gehl Sampath (2004), "Defining an Intellectual Property Right on Traditional Medical Knowledge: A Process-oriented Perspective", 7 JOURNAL OF WORLD INTELLECTUAL PROPERTY, 711 hereafter Padmashree Gehl Sampath (2004), "Defining an Intellectual Property Right..."

⁶⁸⁵ The Secretariat of WIPO has identified a large number of journals and databases containing traditional knowledge data see WIPO (2002), *Inventory of Traditional Knowledge-Related Periodicals*, WIPO/GRTKF/3/5 and WIPO (2002) *Inventory of Online Databases Containing Traditional Knowledge Documentation Data*, WIPO/GRTKF/IC/3/6.

includes inventions patented or described in a printed publication in either the United States or a foreign country, and inventions known or used by others in the United States. Unpublished or unpatented uses of TK in a foreign country are not taken into account.⁶⁸⁶ Last, experiences from patents about Ayahuesca, Quinoa, Neem and turmeric demonstrate that overturning a patent is extremely expensive and time-consuming. As a result, documenting TK and compiling TK databases is a means to make the information available to patent offices and to ensure its inclusion in the prior art so as to prevent abusive patenting.^{687&688}

The best-known example is the Traditional Knowledge Digital Library (TKDL)⁶⁸⁹ that was created in India as a reaction to the Turmeric case. TKDL is a joint project between the National Institute of Science Communication and Information Resources, the department of Indian System of Medicines and Homeopathy and the Ministry of Health and Family welfare. The project was launched by a team gathering experts in traditional Ayurvedic medicines, scientists and patent experts. The project has compiled over 36,000 formulations of traditional Ayurvedic medicines. The formulations have been translated into several languages and classified under the international patent classification. The traditional taxonomy (classification of living things) is linked to the Linnean classification system used in modern science. In all, the TKDL supplies extensive information in a format accepted in patent examinations with sufficient details to evaluate prior art and to provide some security

⁶⁸⁶ 35 USC § 102

⁶⁸⁷ Manuel Ruiz Müller (2002), *The International Debate on Traditional Knowledge as Prior Art in the Patent System: Issues and Options for Developing Countries*, Geneva: Center for International Environmental Law (CIEL) / South Centre, available at www.ciel.org

⁶⁸⁸ Today, in the European Patent Office, *"the searches [for prior art] regularly make use of sources (databases, journals, textbooks, etc) that relate specifically to TK and genetic resources. The search is either directed to sources that specifically relate to TK or genetic resources or to more general sources. Specific to TK is the systematic international patent classification (IPC) A61K 35/78 sqq., the database NAPRALERT accessed through STN, the Traditional Ecological Knowledge Prior Art Database and the Chinese Herb Database available on the Internet. Specific journals pertaining to TK that are available in-house in electronic form include but are not limited to: Australian Journal of Rural Health, Crop Protection, Chinese Journal of Digestive Diseases, Health Promotion International, Journal of Rural Studies, Tropical Medicine and International Health"*. WIPO (2006) *First Collation of Responses to the Questionnaire on Recognition of Traditional Knowledge and Genetic Resources in the Patent System*, WIPO/GRTKF/IC/9/INF/6, p. 168

⁶⁸⁹ TKDL has been described in several publications, notably in Merle Alexander *et al.* (2003), *The role of Registers & Databases in the Protection of Traditional Knowledge, a Comparative Analysis*, United Nations University Institute of Advanced Studies. Hereafter *"The role of Registers & Databases..."*

against minor innovations that could otherwise be considered to be novel.⁶⁹⁰

Following the Indian example, other TK databases have been created and placed in the public domain for defensive protection, notably in China⁶⁹¹, the United States,⁶⁹² and Peru⁶⁹³. More recently, the member-states of the South Asian Association for Regional Cooperation decided to follow the Indian experience and to set up a common traditional knowledge digital library, notably for defensive purpose.⁶⁹⁴

In addition to these databases created for defensive protection, a larger movement of documentation of TK for positive protection is in progress.

5.2.2 TK Databases and Positive Protection

The rationales for documentation and creation of databases go beyond defensive protection.

Some communities resort to databases for their internal use: to preserve their knowledge, and to facilitate its use within the community of TK holders. As an illustration, the Inuit of the Nunavik region in Canada have developed a series of databases on Inuit ecological and environmental knowledge with the objective of applying it to resources management, planning, environmental impact assessment and economic development.⁶⁹⁵ Initially, the Inuit relied mainly on scientific knowledge available outside their territories. But, they realized that this information

⁶⁹⁰ CBD (2005), Composite Report on the Status and Trends Regarding the Knowledge and Practices of Indigenous and Local Communities. The Advantages and Limitations of Registers, UNEP/CBD/WG8J/4/INF/9/, p. 17 hereafter CBD (2005) The Advantages and Limitations of Registers (...)

⁶⁹¹ China Traditional Chinese Medicines Patent Database, for more information, see doc WIPO/GRTKF/IC/3/6

⁶⁹² The Traditional Ecological Knowledge Prior Art Database, developed by the American Association for the Advancement of Science, available for consultation at <http://ip.aaas.org/tekindex.nsf>

⁶⁹³ Law 27811 of 2 July 002 Established the Regime for the Protection of Collective Knowledge of Indigenous People Related to Biodiversity. It provides for three types of register: a notational public register for defensive protection and a national confidential register and local registers for positive protection.

⁶⁹⁴ Business India (2004) "Digital Library for Traditional Knowledge in SAARC region", New Delhi, 27 December and The Financial Express (2005) "SAARC to Set Up Traditional Knowledge Digital Library", New Delhi, 3 January

⁶⁹⁵ S M. May and L. Brooke (1997) "Inuit Science: Nunavik's Experience in Canada" in IUCN Inter-Commission Task Force on Indigenous Peoples, *Indigenous Peoples and Sustainability: Case and Actions*, p 353-361

was insufficient and inadequate to address many issues confronting their societies. As a result they launched a research program that brings together Inuit and non-Inuit researchers to set up these databases. The objective has never been to make the database publicly available. It was set up to inform their decision process or government decision process; the data are considered to be confidential between the peoples of the Nunavik Region and the government.⁶⁹⁶

Others communities use databases to foster traditional innovation and/or in their relations with third parties. They set up databases either as an instrument for attracting potential users and negotiating compensation for access, or as evidence of the existence of some rights over knowledge. For instance, in India some initiatives like the People's Biodiversity registers⁶⁹⁷, the Honey Bee Network⁶⁹⁸ or the Farmers Right Information System⁶⁹⁹ initiated large movements of documentation involving TK holders, students and teachers, grassroots functionaries and rural youth.⁷⁰⁰ The first effect of this documentation process has been to arouse a new interest for this knowledge, notably among TK holders, that tended to neglect and depreciate it. The first objective of these initiative was thus to stop the erosion of TK and to conserve it. A second objective was to create cross-fertilization among TK holders by breaking borders among local communities in order to revitalize traditional innovation. A third objective was to link TK holders with modern science and firms interested by commercial use of traditional knowledge. For that purpose, for each piece of knowledge the databases identify the name of individuals or the community who contribute it. The Honey Bee Network collaborates with the National Innovation

⁶⁹⁶ See Merle Alexander *et al.* (2003), *The role of Registers & Databases ...*, pp. 14-16

⁶⁹⁷ Madhav Gadgil *et al.* (2000), "New Meanings for Old Knowledge: The People's Biodiversity Registers Program", 10 ECOLOGICAL APPLICATION 1307, Gadgil, Madhav (2000), "People's Biodiversity Registers: Lessons learnt" 2 ENVIRONMENT, DEVELOPMENT AND SUSTAINABILITY 323 and Gadgil, Madhav *et al.* (2005), *People's Biodiversity Register: A Methodology Manual*. Indian Institute of Science - Centre for Ecological Sciences / Agharkar Research Institute, Bangalore, Karnataka, India / Pune, Maharashtra, India, available at ces.iisc.ernet.in/hpg/cesmg/pbrmanualnew.pdf

⁶⁹⁸ Anil K Gupta (2001) "Framework for rewarding indigenous knowledge in developing countries: Value chain for grassroots innovations", Paper presented at WTO Experts Committee, 3 September

⁶⁹⁹ See Farmers Rights Information System at <http://www.inssrf.org>

⁷⁰⁰ RV Anuradha, Taneja, B, and Kothari, A. (2001), *Experiences with biodiversity policy-making and community registers in India*, IIED Biodiversity and Livelihoods Group. ABS case study n°3, and G. Utkarsh (2002) "Documentation of Traditional Knowledge: People's Biodiversity Registers (PBRs)", Foundation for Revitalization of Local Health Traditions (FRLHT), India. Available at: <http://www.ictsd.org/dlogue/2002-04-19/Utkarsh.pdf>

Foundation (NIF), established in 2000 by the Department of Science and Technology of India, to promote database management, research and development and IPR management. Further, the Gujarat Grassroots Innovations Augmentation Network (GIAN), established in 1997 links innovators with modern science and technology, market research, design institutions and funding organizations. These organizations can mediate and negotiate on behalf of TK holders with entrepreneurs and potential investors. Last, these databases include a two-stage mechanism of prior informed consent. In the first stage, a TK holder allows the NIF to place his innovation in the database and to combine it with other innovations. The second stage occurs when a potential commercial application of an innovation is developed, the NIF propose a benefit-sharing agreement to the knowledge holder and negotiate on his behalf with the potential user.

Among the existing databases, some are public, some are confidential and some combine different levels of access for different categories of uses and users.⁷⁰¹ Some of these databases have been created by law and set up by governmental institutions⁷⁰², but most of them are the fruits of collaboration between NGOs and TK holders themselves.⁷⁰³

5.2.3 Critics and Unresolved Issues

Unfortunately, ongoing experimentations with the creation of TK databases have been slowed down by criticisms and unresolved issues. A first set of criticisms focuses on the notion of TK protection and the public domain. It has been observed that there is a contradiction between defensive and positive protection. Compiling TK in databases available to the public may protect the knowledge from monopolistic commercial exploitation but it does not prevent unauthorized uses of TK.⁷⁰⁴ Rather, it places TK in the public domain, which amounts to a renunciation of rights over such knowledge.⁷⁰⁵ In other words, defensive

⁷⁰¹ In the United States, The Tulalip Tribes are compiling their traditional knowledge and they distinguish “Type A knowledge” reserved exclusively for members of the tribes and “Type B knowledge” that they wish to make available to the public at large.

⁷⁰² See for instance the BIOZULA Database in Venezuela and Peruvian registers described in WIPO/GRTKF/IC/3/6 or in Merle Alexander *et al.* (2003), *The role of Registers & Databases...*

⁷⁰³ See Merle Alexander *et al.* (2003), *The role of Registers & Databases ...*

⁷⁰⁴ Preston Hardison (2003) “Communication to Canadian Indigenous Information Network” 4 August (on file with author) and Devinder Sharma (2002), “TK Digital Library: Another Tool for Biopiracy?” 39 SOUTH BULLETIN 8, available at www.southcentre.org

⁷⁰⁵ Brendan Tobin (2004) “Towards an international Regime for Protection of Traditional Knowledge: Reflections on the role of Intellectual Property Rights” paper

protection is incompatible with positive protection. A related criticism points out the absence of clear rights to TK databases and the knowledge it contains.⁷⁰⁶

A second set of criticisms argues that placing TK in databases changes the nature of the knowledge, freezes it and interrupts the process of traditional innovation.⁷⁰⁷

A third set of criticisms focuses on the relation between TK holders and the database. A database does not provide a right over the knowledge as such to the benefit of TK holders. Furthermore, in cases where TK holders do not themselves compile the TK database, the articulation of rights between the TK holders, who have rights in the TK data, and the database compilers, who have rights in the database containing the TK data, is unclear.⁷⁰⁸ In the same spirit, the creation of some databases have been blamed for not taking into account customary law and local context of innovation.

5.3 Why Protect TK: Utilitarianism as a Complementary Justification⁷⁰⁹

After explaining how TK holders attempt to protect their knowledge, and before coming back to the criticisms and unresolved issues, it is worth discussing the justifications behind TK protection. In the previous section I explained what I believe are the limits of rights-based justifications. In this section, I explain how a utilitarian approach – as I have used in the first two parts of this dissertation – is useful to justify TK protection and design a protection mechanism. Looking at the grant of property rights from a utilitarian perspective is to regard property rights as an instrument to obtain the greatest good for the greatest number. In order to translate this ideal, most scholars use wealth

presented at the International Conference on "Bioethical Issues of Intellectual Property in Biotechnology", Tokyo, Japan, 6-7 September available at www.shf.ac.uk/ipgenethics/conference/papers/Tobin.pdf

⁷⁰⁶ *Ibidem* and CBD (2005) *The Advantages and Limitations of Registers* (...)

⁷⁰⁷ Graham Dutfield (1999) "Protecting and Revitalising..."

⁷⁰⁸ Merle Alexander *et al.* (2003), *The role of Registers & Databases...*, p. 35

⁷⁰⁹ This analysis of utilitarian arguments as a justification for the protection of TK relies heavily on the similar analysis developed by Padmashree Gehl Sampath. However, we reach very different conclusions. She suggests resorting to trade secret while I suggest codifying TK and creating databases. See Padmashree Gehl Sampath (2004), "Defining an Intellectual Property Right ..."

maximization as the criterion and economics as the methodology to assess the effect of rights.

To consider a regime of protection for TK from a utilitarian perspective, one must look at the consequences of the creation and the attribution of property rights in terms of the increase of utility (incentive effect). When used to explain how intellectual property laws or other forms of knowledge control and exchange function, utilitarianism looks at the nature of knowledge and its usefulness as the key criteria to identify the object of protection and the beneficiaries. Rights are regarded as an incentive to produce and/or disseminate the desired knowledge. Therefore, a possible contribution of a utilitarian approach might be to identify different types of knowledge, their respective usefulness, and the effect that different protection mechanisms could have on the provision and/or dissemination of different types of knowledge.⁷¹⁰ Because it takes into account these elements, a utilitarian or goal-based approach is more helpful to create effective, customized and transferable property rights and to provide criteria precise enough to identify the object of protection, the form, the scope of protection and the beneficiaries.

An additional advantage of a utilitarian justification of intellectual property lies in the possible benefit from the lessons of knowledge economics. Knowledge economics focuses on the conditions and the costs of knowledge production and dissemination. It plays an important part in the justification of intellectual property law whose main rationale – in a utilitarian perspective – consists of creating the best conditions for the production and the use of knowledge within society to further its progress. Some recent evolutions in knowledge economics might be particularly relevant to design accurate protection mechanisms for TK.

In this article, I cannot identify the useful characteristics of all categories of TK. I focus on the useful characteristics of ethnobotanical knowledge, which can be used for R&D in various bio-industries. It is likely that part of the analysis could be relevant for other elements of TK such as traditional environmental knowledge. In the following paragraphs, I use

⁷¹⁰ This does not mean that there is no reason for a comprehensive international treaty on TK protection or model legislations by which states set themselves general objectives in terms of TK protection. However, the implementation of those objectives will require different mechanisms for different forms of TK with different usefulness. Actually, WIPO has already divided TK in two categories: traditional knowledge *sensu stricto* and traditional cultural expressions because of the difference of nature and usefulness of these categories of knowledge, but further divisions might be necessary.

TK to specifically designate ethnobotanical knowledge. According to the proposed approach in the following paragraphs, I look at (1) the usefulness of ethnobotanical knowledge, (2) its characteristics, and (3) the incentive effects of intellectual property rights.

5.3.1 Contribution of Ethnobotanical Knowledge to Bio-Industries' R&D

To understand the contribution of TK, one must first remember the input provided by biodiversity in the R&D process in bio-industry (*Cf.* Part Two, Chapter One). Bio-industry can be seen as defense efforts against a hostile biological world that are perpetually eroding and must be constantly renewed. The same forces that are operating against the human domain are also at work against other living organisms. Any life form that survives has developed resistances that are successful in a contested environment.⁷¹¹ It is for the retention of these existing strategies of resistance that bio-industry collects plants or other biological resources and screens them to identify pharmacologically active compounds⁷¹².

TK can provide a valuable contribution towards this collection of screened plants. There are three strategies for collecting plants for screening programs: random, taxonomic and ethnobotanical. Random collecting is an attempt to sample as much taxonomic diversity as possible. The taxonomic approach is a more guided approach to select species for screening that belong to certain families or genres that are likely to contain certain classes of compounds. The ethnobotanical approach consists of selecting the plants to be collected on the basis of their uses in traditional medicine. Once the plants have been selected and collected according to ethnobotanical knowledge, they can be randomly screened. In that case, the contribution of ethnobotanical knowledge

⁷¹¹ Timothy M. Swanson (1996), "The Reliance of Northern Economies on Southern Biodiversity: Biodiversity as Information", 17 *ECOLOGICAL ECONOMICS*, p. 2

⁷¹² Natural product research is far from being the only source of novel active compounds; it is rather a complement to the chemical synthesis of new drugs. However a study made in 1989 in the US estimated that, 25% of drugs' active ingredients were extracted or derived from plants. Another study carried out in 1993 estimated that in the US 57% of the prescriptions contained at least one major active compound now or once derived after compounds derived from biodiversity. See Peter P. Principe (1989) "The Economic Significance of Plants and Their Constituents as drug", in H. Wagner, H. Hikino and N.R. Farnsworth (eds.) *ECONOMIC AND MEDICINAL PLANT RESEARCH*, Volume 3, pp. 1-17, Academic Press, London, U.K. and Grifo, F. T. and D. R. Downes (1996), "Agreement to Collect Biodiversity for Pharmaceutical Resource: Major Issues and Proposed Principles", in Brush, S. and D. Stibansky (eds.), *Valuing Local Knowledge*, Washington D.C.: Island Press

consists of increasing the probability of identifying active compounds. Ethnobotanical knowledge can provide an additional contribution when scientists look at the uses of plants in traditional medicines and test their effectiveness.⁷¹³ Finally traditional modes of preparation can provide further clues to active chemical compounds.⁷¹⁴

The contribution of ethnobotanical knowledge to drug R&D is very often mentioned and illustrated by examples but there are actually few serious estimations of its value. However, some studies comparing the random collection and ethnobotanical collection approaches have observed a four-fold increase in the probability of drug discovery.⁷¹⁵ Otherwise, many pharmacological or chemical studies report the use of TK without estimating its value.⁷¹⁶ The value of TK is also attested to by the existence of a series of related disciplines and journals dedicated to its documentation (*Cf. Chapter 2*). Finally, it has been observed that seventy-four percent of chemical compounds used in drugs today have the same or related use in western medicine as they do in traditional medical systems.⁷¹⁷ It is therefore reasonable to state that TK has and will continue to play a valuable role in drug R&D either in terms of identification of plants for screening or as clues to their pharmaceutical activity.⁷¹⁸

Furthermore, large chemical and pharmaceutical companies are used to resorting to all sorts of collaborations with a large range of “knowledge providers”. Indeed, given the large array of discoveries in molecular biology, genetics and related fields, biotechnology has become such a diverse industry, in terms of its underlying science and discoveries that not even the largest pharmaceutical companies have the internal

⁷¹³ James S. Miller (1992), “The Discovery of Medicines and Forest Conservation” in, Robert P. Adams and Janice E. Adams (eds.), *Conservation of Plant Genes. DNA Banking and in vitro Biotechnology*, San Diego: Acad. Press, p. 123

⁷¹⁴ Elaine Elisabethsky (1991), “Folklore, Tradition or Know-How?”, *CULTURAL SURVIVAL QUARTERLY*, SUMMER, pp.9-13

⁷¹⁵ See Michael Balick (1990), “Ethnobotany and the identification of Therapeutic Agent from the Rainforest”, *Bioactive Compounds from Plants*, Ciba Foundation Symposium p. 26-28.

⁷¹⁶ Lieting and van den Berghe (1998). “Leads for Antivirals from Traditional Medicines” in Prendergast et al.(eds.), *Plant for Food and Medicine*, The Royal Botanical Gardens, Kew, pp.333-344, Labadie, R.P. et al. (1989) “An Ethnopharmacological Approach to the Search for Immunomodulators of Plant Origin”, 55 *PLANTA MEDICA* 339-348

⁷¹⁷ N. R. Farnsworth (1988), “Screening Plants for New Medicines” in E. O. Wilson, (ed.) *Biodiversity*, Washington, DC: National Academy Press, pp. 83-97

⁷¹⁸ Elaine Elisabethsky (1991), “Folklore, Tradition or Know-How?”, *CULTURAL SURVIVAL QUARTERLY*, Summer, pp.9-13

capacities to cover all the areas.⁷¹⁹ In this context, it seems that TK holders willing to do so could work as “knowledge providers” for those large chemical or pharmaceutical companies.

5.3.2 The Tacit Dimension of Traditional Knowledge

Once one has identified the nature of the actual or potential contribution of TK to the R&D of drugs or other bio-industries, one has to look closer at the characteristics of this type of knowledge. TK includes identification of plants, their use and possible recipes for their use.

As I explained in the previous chapter, TK fits into the definition of tacit knowledge or can be assimilated to tacit knowledge. The tacitness of TK is probably one of the major obstacles to its further use in R&D. Both the importance of ethnobotanical knowledge and the problem of tacitness are well illustrated by the largest study on the commercial use of biodiversity. Kerry Ten Kate and Sarah Laird observe that close to half of the companies they interviewed make use of TK. However, they immediately add that eighty percent of all companies that use ethnobotanical knowledge rely solely on academic literature and databases as their primary source for this information.⁷²⁰

This has three implications. First, TK is rarely accessed as tacit knowledge through field collection. Second, the knowledge used by bio-industry is the part of TK that has been codified or translated in academic journals or databases. Third, at present most of this codification or translation of TK is carried out by academics with little involvement of TK holders.

5.3.3 An Incentive to Codify

Once one has identified the possible contribution of TK to the R&D process in the bio-industries, the next step is to identify property rights that will have an appropriate incentive effect on the production and/or the dissemination of TK. If one considers the theoretical evolution of

⁷¹⁹ Walter W. Powell (2001), “Networks of Learning in Biotechnology: Opportunities and Constraints Associated with Relational Contracting in Knowledge-Intensive Field”, in Rochelle Dreyfus, *et al.*, *Expanding the Boundaries of Intellectual Property, Innovation Policy for the Knowledge Society*, Oxford University Press and Paul P. Saviotti (1998), “Industrial Structure and the Dynamics of Knowledge Generation in Biotechnology” in Senker and van Vliet (eds.), *Biotechnology and Competitive Advantage; Europe Firms and the US Challenge*, Edward Elgar, pp. 19-44

⁷²⁰ Kerry Ten Kate and Sarah Laird (1999), *The Commercial Use of Biodiversity*, Earthscan, London, p. 62. See also Russel L. Barsh (2001), “Who Steals Indigenous Knowledge?” 95 AMERICAN SOCIETY OF INTERNATIONAL LAW PROCEEDINGS, 153

knowledge economics, it appears that there is not so much a need to restrict access – as for most of TK, its tacit dimension already limits access. There is rather a strong need for an incentive to reveal knowledge and to provide mechanisms that favor trade of knowledge.

Under the classical economic understanding of innovation developed by Arrow⁷²¹ and Nelson⁷²², it is not clear that there is a justification to protect TK through exclusive property rights. I briefly recall Arrow and Nelson's few central points. First, from a firm standpoint, undertaking R&D activities is regarded as an investment decision. Second, R&D can be conceived of as an activity intended to produce information or knowledge. Third, knowledge is a public good, i.e. a non-excludable and non-rival good. As a non-excludable good, knowledge is likely to be underprovided, from society's perspective, because the social return from investment in R&D exceeds private return. By providing a legal mechanism to exclude third parties from knowledge use, IPRs enable knowledge producers to capture a greater part of the benefits of their investment in knowledge production, therefore acting as incentive for the production of knowledge. However, knowledge is also a non-rival good, which means that it should be freely available. There is thus a dilemma or a tradeoff between investment and access or, in other words, between dynamic efficiency and static efficiency.

Under such an understanding of knowledge production and dissemination, is there an economic reason to protect such knowledge and by what kind of protection mechanism? TK could itself be regarded as R&D because it consists of knowledge that has resulted from a long process of innovation by TK holders; some people want to acquire it and TK holders want to protect it, it is therefore valuable knowledge. Valuable knowledge is a public good, as such, there seems to be reasons to protect TK by IPRs mechanisms. On the contrary, TK already exists, so there is no need to create IPR incentives to produce it; it has been created without such incentives. Moreover, TK is also a non-rival good, which suggests that it should be open-access. In economic terms, there appears to be no gain in dynamic efficiency that justifies losses from static inefficiency, such as the under-utilization of knowledge induced by IPRs. Therefore, there is no apparent economic or utilitarian argument

⁷²¹ Kenneth J. Arrow (1962), « Economic Welfare and the Allocation of Resources for Inventions » in Richard R. Nelson (ed.) *The Rate and Direction of Inventive Activity: Economic and Social Factors*, Princeton University Press, Princeton

⁷²² Richard R. Nelson (1959), « The Simple Economics of Basic Scientific Research », *JOURNAL OF POLITICAL ECONOMY*, vol. 67

to protect TK. That is probably why most proponents of TK protection reject utilitarian justifications.

As suggested by Padmashree Gehl Sampath, one cannot stop the analysis at this point. Indeed, both the increasing cumulative and collective dimensions of innovation,⁷²³ especially in biotechnologies and the increased awareness of the role of tacit knowledge, have led to some changes in the economic theorization of innovation and/or knowledge production that are relevant in our examination of the justification of TK protection.⁷²⁴ First, the collective and cumulative dimension of innovation implies that access to previous inventions and preexisting knowledge become important incentives to innovate whereas transferring and exploiting preexisting knowledge is difficult and costly. Second, it is important to realize that describing knowledge as a public good only applies to codified knowledge.

Indeed, tacit knowledge does not qualify as a perfectly non-exclusive good. When knowledge is expressed through perfectly codified instructions that enable an easy reproduction of knowledge, it is uncontrollable or non-excludable.⁷²⁵ Actually, knowledge is often a mix of codified instructions and tacit knowledge based on practical experiences that can only be acquired in the specific laboratory where the research has been undertaken. The tacit dimension of knowledge gives some control to its owner because it can only be transmitted by voluntary demonstration and apprenticeship. Therefore, tacit knowledge has some excludability.⁷²⁶ As most TK consists of tacit knowledge, or can be assimilated to tacit knowledge, it might be said that it is partly excludable and can only be accessed by a voluntary demonstration of knowledge holders. When TK has been codified in academic databases or journals, TK holders have already willingly demonstrated it. However, they may have been unaware of the consequences of this revelation.

Several costs of knowledge also limit the benefit of non-rivalry. The effect of non-rivalry, i.e. the capacity of knowledge to be used an infinite number of times by an infinite number of persons, can be seriously

⁷²³ See notably Robert P. Merges & Richard R. Nelson (1990), « On the Complex Economics of Patent Scope », 90 COLUMBIA LAW REVIEW 839 or Jerome H. Reichman (2000), "Of Green Tulips and legal Kudzu: Repacking Rights in Subpatentable Innovation", 53 VANDERBILT LAW REVIEW 1743

⁷²⁴ Padmashree Gehl Sampath (2004), "Defining an Intellectual Property Right ...", p. 24

⁷²⁵ Except obviously when it is codified with a secret code.

⁷²⁶ Dominique Foray (2000), *L'économie de la connaissance*, pp 67-68

limited by three categories of costs: the costs of codifying, transmitting, and acquiring knowledge. This implies that the tacitness of knowledge reduces the benefits of its non-rivalry. The cost of transmission includes the cost of transferring knowledge including the cost of the medium.⁷²⁷ The costs of acquisition refer to the costs of training a large audience that is able to understand and use the knowledge. Without those investments, the value of non-rivalry is limited or void.⁷²⁸ One can therefore distinguish specific non-rival goods like esoteric or very up-to-date knowledge from quasi-universal non-rival goods like the law of gravity. The presence of those costs implies that TK cannot be used as widely as its potential. In economic terms, one would say that TK is not available for diffusion at marginal cost.⁷²⁹ However, two categories of costs have been reduced. The development of the information and communication technologies, notably in TK-rich countries like India and China, lowers the cost of transmission. Similarly, the development of scientific disciplines like ethnobotany, ethnopharmacology, or economic botany creates a new audience able to understand TK. Therefore, the costs of codifying appear to be the main limit to the benefits of non-rivalry.

Therefore, an important part of TK consists of tacit knowledge that does not correspond to the notion of public good. There is not a need to restrict access in order to provide an incentive to invest in the production of TK. Rather, there is a need for an incentive to codify TK so as to increase its transferability and use.⁷³⁰

In addition, it is important to understand the relationship between codification and intellectual property. Codification is a condition for the granting of an intellectual property right. A property right can only be granted on well-identified and described pieces of knowledge.⁷³¹ Codification also provides an argument for the granting of IPRs. Indeed, codification is a public good, or in other words, knowledge becomes a

⁷²⁷ Dominique Foray (2000), *L'économie de la connaissance*, pp. 69-70

⁷²⁸ Michel Callon (1994), «Is Science a Public Good? Fifth Mullins Lecture», *SCIENCE TECHNOLOGY AND HUMAN VALUE*, 19(4)

⁷²⁹ Padmashree Gehl Sampath (2003), "Defining an Intellectual Property Right on..."

⁷³⁰ A CBD report on TK registers and databases notes that "indigenous and local communities had had some practical protection through the high transaction costs of acquiring and using traditional knowledge that may be significantly lowered with [databases] and associated electronic data-mining techniques", See CBD (2005) *The Advantages and Limitations of Registers (...)*, p. 16

⁷³¹ For example, in copyright law, protection is given to expressions but not ideas; and in patent law, protection is given to described inventions but not know-how.

public good when it is codified, as such there might be a need for protection and incentives.

In conclusion, the lesson of this utilitarian approach is twofold. From the perspective of lawmakers willing to promote the conservation, use, and creation of TK, there seems to be a strong argument for incentives to codify TK. The lesson of this utilitarian approach is not an argument against the creation of property rights in TK, as it is called by article 8j of the CBD, as it is enacted in some national legislation and as it is discussed in WIPO-IGC. The lesson is that even if this property right exists, the transferability and the use of ethnobotanical knowledge, at least outside of the community, will remain very limited in the absence of codification. This assertion is confirmed by the figures mentioned above: eighty percent of firms using ethnobotanical knowledge use the TK codified by academics. From the standpoint of TK holders, an important choice must be made. If their priority is to maintain control over their ethnobotanical knowledge in the absence of a clear possibility to obtain intellectual property protection, the best option probably consists of keeping their knowledge tacit. If they want open access to their knowledge and obtain compensation for its use, they should consider codifying their knowledge and search for relevant intellectual property protection.

5.4 Theory and Practice: Codification and Databases

The analysis of the justification for TK protection from a utilitarian perspective supports those TK holders that have launched into creating databases. Indeed, the material result of TK codification might be academic journal articles or databases. As publication in academic journals implies a total loss of control over published knowledge, databases appear to be the best way to codify TK. It is not sufficient to give theoretical support to the creation of TK databases; first one must examine whether there is a property right on databases that works as an incentive to codify or whether it is necessary to envisage the creation of new IPRs and then return to the criticisms of TK databases.

5.4.1 IPRs and Databases

Is there a right available or is it necessary to envisage the creation of a new IPR? Countries interested in fostering codification of TK in their territory could enact national legislation on the condition of access to TK databases. National laws may not be the answer because they only

extend as far as national borders. One of the benefits of digital databases is their ability to increase the international transferability of knowledge. Therefore, it may be more effective to look for available international protection so that it may have an effect on the use of TK outside of national borders. There is some logic to first looking at rights available to TK holders in the current state of the law and then at rights that require some international action, such as the negotiation of a new international treaty on TK protection. In this section, I limit myself to a brief examination of the international protection currently available for databases.

In most countries databases are protectable under copyright and/or through technological measures. In the European Union and some other countries, databases may additionally qualify for protections under the *sui generis* database right.

With regards to copyright, the conditions and scope of protection vary among states. As to the conditions of protection, under the “intellectual creation” approach to the originality standard that is taken by most civil law jurisdictions and some common law countries, most notably the United States, the author of a database must demonstrate a limited modicum of creativity in the selection and arrangement of data. While under the “sweat of the brow” approach, he must demonstrate investment in time and/or money in the compilation of the database⁷³². Despite the differences in the conditions of protection, there is little doubt that a TK database would qualify for copyright protection in most countries. Regarding the scope of protection, as it somehow depends upon the conditions of protection, there are similar differences among national legislations. In countries resorting to the “intellectual creation” doctrine, it is very limited: it is the copying of the selection and/or arrangement of data that constitutes infringement, not the copying of the data. In countries following the “sweat of the brow” doctrine, the scope of protection is broader but still limited: the copying of a substantial proportion of the data infringes the copyright but not the copying of small amounts of data.⁷³³

It is also possible to protect databases through a *sui generis* database right first enacted in the European Union and soon to be in force in close to

⁷³² Mark J. Davison (2003), *The Legal Protection of Database*, Cambridge: Cambridge University Press, pp. 13-21

⁷³³ *Ibidem*, pp. 26-27

fifty states⁷³⁴. The makers of a TK database should have no difficulty in qualifying for protection. The conditions of protection are similar to copyright under the “sweat of the brow” approach, in that in order to qualify for the right the maker of the database must make a substantial investment in obtaining, verifying, or presenting the contents of the database. As for the scope of protection, it is slightly different: if a database qualifies for the *sui generis* right, database makers may prevent the unauthorized extraction and/or re-utilization of substantial parts of the database, and the repeated and systematic extraction and/or re-utilization of insubstantial parts of the database’s contents. The *sui generis* database right therefore provides stronger protection than copyright. However, it is only in force in a limited number of countries and protection is only available for nationals or residents of these countries.⁷³⁵ It is beyond the scope of this article to discuss whether countries rich in TK should consider enacting similar legislation, as the protection of databases is a much broader issue than TK databases⁷³⁶.

⁷³⁴ In addition to the twenty five member states of the European Union, the database *sui generis* right exists or might exist in the foreseeable future in a series of other European Countries, Turkey, Israel, South Africa, Mexico and some Latin-American countries. See Mark J. Davison (2003), *The Legal Protection of Database*, p. 234

⁷³⁵ Nevertheless, even if countries rich in traditional knowledge do not wish to enact an EU-like *sui generis* right on database, there might be a possibility to benefit from the protection in countries where this right exists even though the EU directive says the opposite. After a very detailed comparison between the two forms of copyright protection and the *sui generis* right, Professor Davison argues that except differences of terminology, the *sui generis* right is not different from copyright. Such a difference cannot mask the substantive reality that it is a form of copyright for databases. If his analysis is right, the EU Member States have an obligation to accord national treatment to all nationals of states that are signatories to international agreements such as the TRIPS agreement and the Copyright Treaty. Therefore, the maker of a TK database (or the state from which they are nationals) could use this argumentation to claim the protection of the EU *sui generis* right within the territory of the states in which it is in vigor. See Mark J. Davison (2003), *The Legal Protection of Database*, pp. 221-226.

⁷³⁶ One can however mention the fact that three studies have been carried out for WIPO Standing Committee on Copyright and related right on this issue. One concentrated on India and concluded that it should envisage the adoption of a legislation protection unoriginal database. The three others look at Latin American or developing countries and countries in transition as a group and conclude that they have no strong interest in the adoption of such legislation. See Phiroz Vandredala (2002), *A study on the impact of protection of unoriginal databases on developing countries: Indian experiences*, WIPO/SCCR/7/5; Yale M. Braunstein (2002) *Economic Impact of Database Protection in Developing Countries and Countries in Transition*, WIPO/SCCR/7/2; Sherif el Kassar (2002), *Study on the Protection of Unoriginal Databases*, WIPO/SCCR/7/3 and Thomas Rijs (2002) *Economic Impact of Database Protection in Developing Countries and Countries in Transition*, WIPO/SCCR/7/4

Last, it is possible to protect online databases by conditional access systems that serve to control access to an information service⁷³⁷. Here, I must introduce a theoretical distinction. The notion of property rights is slightly different for lawyers and economists. Property rights in the economic sense include not only legal property rights but also other forms of control that produce the same effects of creating some degree of exclusiveness and transferability.⁷³⁸ While copyright and the *sui generis* right provide control over copying parts of a database, conditional access systems provide complete control over access to a database. Under conditional access systems a database owner can condition access to a database through contractual licensing terms, which fix the conditions and payment for use. Therefore, for on-line databases, conditional access systems offer convenient protection for TK holders.

However, it might be worth combining legal and technological protection because once access has been given to a user, copyright, or the *sui generis* right provide stronger protection against third parties. One must recall the distinction between contract and legal property rights. For the most, contracts only bind the contracting parties; they cannot be opposed to third parties. By contrast, intellectual property rights can be opposed to anyone. To illustrate, imagine A has some TK and makes it available to B under certain conditions including an obligation not to communicate the knowledge to third parties. In violation of the contractual terms B makes the knowledge available to C. If A protects his database with conditional access measures, he can sue B for breach of contract but he has no direct action against C. By contrast, if A has an intellectual property right, he can sue B for breach of contract and C for infringement of its property right.⁷³⁹ For this reason, TK holders might combine technological measures and IPRs.

In sum, there already exist some forms of international protection for databases that can provide incentives for the codification of TK. Some

⁷³⁷ Bernt Hugenholtz (1999), "Code as Code, Or the End of Intellectual Property as We Know It", MAASTRICHT JOURNAL OF EUROPEAN AND COMPARATIVE LAW, Vol.6, No3 p. 308-318

⁷³⁸ Yoram Barzel (1997), *The Economic Analysis of Property Rights*, Cambridge: Cambridge University Press, (2nd ed.), p. 3. The fact that technological measures may be a substitute for legal property rights when copyrights legislation forbid their circumvention. See notably the World Intellectual Property Organization Copyright Treaty, articles 11 and 12, the text of the treaty is available at <http://www.wipo.int/documents/en/diplconf/distrib/94dc.htm>

⁷³⁹ This is the legal strategy used in open-software, see David Mc Gowan (2001) "The Legal Implications of Open-Source Software", UNIVERSITY OF ILLINOIS LAW REVIEW, vol. 2001, p. 242 (Cf. section 5.4)

additional forms of protection may appear in the future as a result of the discussions within WIPO on database protection that were interrupted by the lack of consensus within the United States on the best form of protection.

5.4.2 Replies to Database Critics

Sceptics argue that the use of databases for defensive protection is incompatible with positive protection because it would effectively place TK in the public domain. This assertion confuses notions of patent law and copyright law and deserves to be qualified. It is true that an invention described in a text or a database can no longer be patented, as it would lack novelty. In that sense, it can be said that it is placed in the public domain. However, the description itself can still be protected by copyright, the *sui generis* database right, or above all technological measures. Therefore, TK described in databases can be taken into account as prior art by patent offices even if access to the database is not freely accessible. As an illustration, let us compare with a scientist who makes a discovery and describes it in an online academic journal. This discovery can no longer be patented as it would lack novelty. However, the article is protected by copyright and access to the journal can be limited by conditional access systems, i.e. only subscribers may access. In practice, people pay high subscription fees to access descriptions of valuable scientific information. There is no reason why peoples interested in accessing valuable TK would not pay a fee to access a TK database. In addition, access to the database could be conditioned not only for the payment of a fee but also for an obligation not to share the knowledge with third parties. Lastly, the European Patent Office (EPO) and the makers of the Traditional Knowledge Digital Library (TKDL) recently concluded an agreement according to which the EPO will have access to the TKDL while it will remain inaccessible to third parties.⁷⁴⁰ This agreement is practically helpful but it should not give the impression that similar agreements are a legal necessity to combine defensive and positive protection.

Similarly, some TK holders complain about the notion of the public domain. Either they claim that the notion of public domain does not exist in their customary law or they complain that their knowledge has been placed in the public domain by third parties without their prior

⁷⁴⁰ Presentation of a representative of the European Patent office at the 8th session of WIPO-IGC, June 2005

consent⁷⁴¹ and they want protections for their knowledge that is in the public domain. In that latter case, databases enable some control over the use of knowledge in the public domain. A database made up of pieces of knowledge in the public domain (either because they are unprotected, no longer protected or unprotectible) can be protected by intellectual property or by technological measures.⁷⁴² Obviously, the person interested in accessing that knowledge can find another source but he might prefer using the database that offers a large collection of knowledge and a classification system. Facilitating access to knowledge is the very *raison d'être* of databases. In that case, the users might be ready to accept the conditions of access as stipulated by the database maker.

Critics of databases also argue that codifying TK and placing it into databases could be dangerous for traditional innovation because it would fix knowledge in its current state and interrupt the innovation process. This criticism may be legitimate but it is badly formulated. Modern science mixes tacit and codified knowledge. Codification of new discoveries is an important task and it cannot be argued that codification freezes the innovation. To the contrary, some degree of codification is necessary to share knowledge and further innovate.

This criticism highlights the question of the mode of transmission of TK. As I explained above, Indigenous and local communities holding TK face the same options as any organization managing knowledge, they have to choose between a strategy of codification and a strategy of personalization. Thus far indigenous and local communities holding TK have relied for the most part on a strategy of personalization to ensure the devolution of their knowledge. Therefore indigenous and local communities could consider replacing or complementing their strategy of personalization through a strategy of codification. What is true is that if we want to maintain the traditional innovation process, codification must be carried out by or with TK holders, and their organization of innovation must be taken into account. This will be the subject matter of the second part of this essay.

⁷⁴¹ See for example Tulalip Tribes of Washington (2003), "Statement on Folklore, Indigenous Knowledge, and the Public Domain" at the fifth session of the WIPO-IGC, July 09, in WIPO/GRTKF/IC/6/14

⁷⁴² This is precisely why proponents of a strong public domain are very wary about strong protection on database; see notably Jerome H. Reichman and Paul F. Uhler (2003) "A contractually Reconstructed Research Commons for Scientific Data in A Highly Protectionist Intellectual Property Environment", 66 LAW AND CONTEMPORARY PROBLEMS 315

Furthermore, critics of databases rightly point out that there is a problem of articulation between TK holders and the makers of a TK database when TK holders themselves do not make the database.

What TK holders claim is a right to TK as such, not a right to a database. Similarly, article 8J of the Convention on Biological Diversity, as well as some national laws and discussions on misappropriation in WIPO recognize or consider the possibility of a right to TK as such. In contrast, a utilitarian approach suggests that codification might be a practical means for effective protection of ethnobotanical knowledge and that we should consider the possible incentives. In the current state of the law, there exist some property rights to databases that could work as an incentive to codify ethnobotanical knowledge. Those property rights are granted to the codifier, i.e. the person that makes the database. Therefore, they encourage TK holders to codify their knowledge. However, if the codification or creation of the database is not carried out by TK holders themselves, the respective rights of TK holders and the database maker must be respected. This is not a problem specific to ethnobotanical knowledge – it is present each time the maker of a database wants to integrate protected material in its database. The database maker and knowledge holders will have to negotiate the conditions of integration of that knowledge in the database and a formula to share the benefits. The situation is more complex with TK because, in the current state of the law, the existence and the outline of a right to TK remain unclear. However, TK holders can make up for the weakness of their property right by the tacitness of their knowledge: codification of their knowledge in a database is likely to require their voluntary contribution. In addition, creating a TK database facilitates the enforcement of their rights to their knowledge.

Whether TK holders or third parties create a TK database, there will be organizational consequences. A TK database is most likely to include pieces of knowledge belonging to several owners: several individuals, a community, or multiple communities. The database maker may act as a collective rights organization⁷⁴³. If a community of TK holders sets up the database, they will manage the rights of the community and act as an intermediary between the community's internal regime, which grants property rights and rules governing knowledge exchanges within the community, and the external regime, which settles the conditions upon

⁷⁴³ Merle Alexander *et al.* suggest a similar idea in using the term “trust”, I prefer the expression “collective right organization” as it does not always fit in the legal definition of trust; See Merle Alexander *et al.* (2003), *The role of Registers & Databases (...)*, p. 36

which the community agrees to grant access to third parties. If a third party sets up the database, he will act as an intermediary between the knowledge holders and the potential users.

Therefore, we cannot limit our attention to a limited understanding of TK protection through databases or any other device. We must also consider how these protection devices can enable communities to articulate their internal regime, which organizes innovation within the community, and an external regime, which organizes their relation to third parties. This is the subject matter of the following pages.

6. Taking into Account Customary Law to Maintain Traditional Innovation

The claims of TK holders are not limited to the protection of their knowledge but also include the respect of their customary law, or in other words the preservation of their cultural identity and the organizational structure that enables the continuous production, use and conservation of their knowledge. Very often, TK holders argue that they do not need intellectual property rights but rather need the recognition of their customary rights.⁷⁴⁴

6.1 The Current Debate on the Role of Customary Law in the Protection of TK

Usually the demand for recognition of customary law is perceived as deeply embedded in the larger claim of indigenous peoples for self-determination. In this context, indigenous peoples may view the debate on biodiversity and TK as an opportunity to have their voice heard. On the other side of the table, governments, which have cold feet vis-à-vis demands of self-determination, regard any claim for the respect of customary law as a moral or political issue. Governments view the debate on TK protection as only a “pretext” to bring the issue of self-determination to the forefront.⁷⁴⁵

The difficulty with these contentious views on the role of customary law is that they are unlikely to result in a consensual solution. Moreover, they provide little guidance on the design of possible solutions. As a result, except the insertion of a principle for the respect of customary law in WIPO-IGC documents⁷⁴⁶, and in decisions of the Conferences of the

⁷⁴⁴ See notably Four Directions Council (1996), *Forests, indigenous peoples and biodiversity. Contribution of the Four Directions Council to the Secretariat of the Convention on Biological Diversity*, Lethbridge: FDC or the The Mataatua Declaration on Cultural and Intellectual Property Rights of Indigenous Peoples available at <http://aotearoa.wellington.net.nz/imp/mata.htm> or see the minutes of the WIPO-IGC, available at <http://www.wipo.int/tk/en/>

⁷⁴⁵ However, in some States, case law or statute law gives some recognition to customary law

⁷⁴⁶ Document GRTKF/IC/8/5 of the WIPO-IGC, entitled “*Protection of Traditional Knowledge: Revised objectives and Principles*” a Principle (h) of respect for customary use and transmission of traditional knowledge, which provides that “*Customary use, practices and norms shall be respected and given due account in the protection of traditional knowledge, subject to national law and policy. Protection beyond the traditional context should not conflict with customary access to, and use and transmission of, traditional knowledge, and should respect and bolster this customary framework. If so desired by the traditional knowledge holders, protection should promote the*

Parties of the Convention on Biological Diversity⁷⁴⁷, intergovernmental discussions have so far made little headway on this issue.

Beyond these decisions, two possible solutions are usually envisaged for the inclusion of customary law. A first proposal consists of the creation of an international *sui generis* right inspired by the provisions of customary law. A related proposition maintains that existing customary law would provide sufficient protection, if only courts recognized it. However, both proposals seem to be highly problematic.

It is difficult to comment on the proposal to create a *sui generis* right based on customary law because there is no detailed proposal describing what such a right could be. However, this proposal faces practical problems, and above all it does not answer the right question. In practical terms, I have already mentioned above the difficulty faced by WIPO in its attempt to build a *sui generis* regime around the notion of misappropriation. Moreover, the history of intellectual property law reveals a proliferation of *sui generis* regimes, which rarely provide full satisfaction.⁷⁴⁸ Most of all, it implies that the multitude of customary

use, development, exchange, transmission and dissemination of traditional knowledge by the communities concerned in accordance with their customary laws and practices, taking into account the diversity of national experiences. No innovative or modified use of traditional knowledge within the community which has developed and maintained that knowledge should be regarded as offensive use if that community identifies itself with that use of the knowledge and any modifications entailed by that use." (My emphasis)

In the same document the definition of misappropriation includes an item 5 stating that *the application, interpretation and enforcement of protection against misappropriation of traditional knowledge, including determination of equitable sharing and distribution of benefits, should be guided, as far as possible and appropriate, by respect for the customary practices, norms, laws and understandings of the holder of the knowledge, including the spiritual, sacred or ceremonial characteristics of the traditional origin of the knowledge.* (My emphasis)

⁷⁴⁷ In 2002, the Sixth Meeting of the COP (COP-6) adopted a decision on "Article 8 (j) and related provisions", inviting: "Parties and Governments, with the approval and involvement of indigenous and local communities representatives, to develop and implement strategies to protect traditional knowledge, innovations and practices based on a combination of appropriate approaches, respecting customary laws and practices, including the use of existing intellectual property mechanisms, *sui generis* systems, customary law, the use of contractual arrangements, registers of traditional knowledge, and guidelines and codes of practice." Two years later, the COP-7, adopted Decision VII/16 on the same issue "Article 8(j) and Related Provisions". Section H of the Decision was on the development of elements of *sui generis* systems for the protection of traditional knowledge, innovations and practices. Drawing on the work of the Working Group on Article 8(j), its annex offered the following list of potential elements, notably: "1) (...), 2) (...), 3) (...), 4) Recognition of elements of customary law relevant to the conservation and sustainable use of biological diversity with respect to: (i) customary rights in indigenous/traditional/local knowledge; (ii) customary rights regarding biological resources; and (iii) customary procedures governing access to and consent to use traditional knowledge, biological and genetic resources, 5.(...)". (My emphasis)

⁷⁴⁸ Jerome H. Reichman (1994), "Legal Hybrids..."

intellectual property laws have similar provisions, which is far from certain. Therefore, this proposal will not help to articulate a diversity of customary regimes within a single global legal regime. Any attempt to design a *sui generis* right with a detailed international standard (one size fits all) inspired by one of the customary regimes will have the same rigidity as existing IPRs and will not be able to accommodate the diversity of customary laws. On the contrary, if we create national regimes or community-based legal regimes tailored to include customary law, it points to the second proposal.

As for the protection of TK by customary law and application of customary law by foreign jurisdictions, it presupposes several legal conditions, and as well as facing practical difficulties and objections on principle. As a first legal condition, the state hosting the community must give legal force to the community's social norms or customary law. The recognition of the customary law is a long-term claim of indigenous peoples and it might take a long time before all their host states recognize it as part of their legal system. The second legal condition that must be met is for states where TK is used; these states must have a provision in their private international law referring to the law of the state hosting the community, which in turn must refer to the customary law of that community.⁷⁴⁹ If this condition is ever fulfilled, it may not be before long. From a practical standpoint, considering customary law as a system for protection of TK elicits a problem of clear identification of the relevant customs and its precise content. It is unclear whether all different customary laws contain precise provisions on the use of TK by third parties. For a potential user, it would create a lot of legal uncertainty because it would be difficult to identify whether an element of TK is protected or not, what the exact limits of the protected knowledge are, and the identity of the right holder. For TK holders, it would be costly and difficult to go to a foreign court and bring evidence of the content of customary law and its breach.

Lastly, there is a more fundamental objection. If customary laws are to be given legal force for ruling the relations among members of the community, and possibly the behavior of third parties when they are in the territory of the community, there is no clear reason why it should apply to outsiders outside territory of the community. Law has territorial

⁷⁴⁹ Regarding intellectual property law, states tend to apply their legislation on their territory and not the legislation of the state of origin of the protected material. Application of the principle of mutual recognition may provide an exception, but it is unlikely to be used in the absence of an international standard of protection (Cf. section 4.4)

effect. In some circumstances, law applies to nationals outside national jurisdictions. In principle, law does not apply to non-nationals outside of national territory. The same is true for local, regional or community law.

6.2 A Change of Perspective

In order to progress on this issue, it may be worth adopting a different perspective. Let us divert one instant our attention from the tensions between indigenous communities and their host states and recall that local communities with no demand for self-determination also claim that their knowledge is ruled by customary law or social norms that should be respected by third parties.

Then, if we adopt the same standpoint as in the two first parts of this dissertation, the discussion on customary law appears as an issue of self-regulation. Indeed, customary law regulating traditional innovation includes the constitutive elements of self-regulation: (1) some degree of collective constraint, (2) other than that directly emanating from government, (3) to engender outcomes which would not be reached by individual market behavior alone⁷⁵⁰. In this perspective, rather than being a distinct and marginal issue, the protection of TK appears emblematic of a general challenge for intellectual property law and scholarship: recognizing the importance of different forms of self-regulation in the organization of innovation. Professor Robert Merges observes, “*Many scholars – and particularly legal scholars– have tended to have a state-centric, if not legal-centric, view of appropriability. This “top-down” view must give way to a different conception: one where bottom-up institutions of all kinds contribute importantly to appropriability conditions. This view is in keeping with the recent trend in law and economics scholarship toward a discussion of social norms in conjunction with formal law.*”⁷⁵¹

In this perspective, the comparison between traditional innovation and science is particularly enlightening. In fact, both traditional innovation and science can be seen as examples of what Professor Merges calls the historical permanence of appropriability structures or informal institutions that facilitate innovation by virtue of shared norms. These appropriability institutions are bottom-up institutions in the sense that

⁷⁵⁰ Julia Black (1996) “Constitutionalising Self-Regulation”, 59 MODERN LAW REVIEW, 24-55

⁷⁵¹ Robert P. Merges (2004) “From Medieval Guilds to Open Software: Informal norms, Appropriability Institutions, and Innovation”, Conference on the Legal History of Intellectual Property, University of Wisconsin Law School, November 13

they are norms-based groups that develop their own internal governance structure. They rely on group norms as opposed to formal legal enactments for the creation and enforcement of some form of IPRs. According to Professor Merges, these appropriability institutions require at least two things: (1) some way to differentiate insiders or members from outsiders and (2) some shared norms determining what knowledge must be shared by all members and what knowledge can be individually appropriated.

The point here is not to suggest any similarities in the provision of customary law and the norms of science, as it has been suggested in failed attempts to associate TK holders and academics in defense of the public domain⁷⁵². Rather, the purpose of this comparison is to point out that both science and traditional innovation are innovation systems ruled by informal rules. The descriptions of social norms or customary laws that regulate science and traditional innovation by sociologists of science (*Cf. part one, chapter 2*) and anthropologists (*Cf. part three, chapter 2*) suggest they include the two elements that Professor Merges identifies as constitutive of this informal or appropriability institutions.

It is in this perspective that I begun the third part of this dissertation by insisting on the fact that the issue is not (only) to conserve old knowledge but to maintain systems of traditional innovation. Then, I described the property regime of traditional knowledge that existed before the launch of this debate on TK protection. Later in chapter 4, I pointed to a risk of erosion of customary laws. This enables me to identify the real issue within the discussions on customary law.

6.3 The Real Issue: Articulating Customary Law and Formal IP Law

With that perspective, it appears that we do not have to deal with the protection of TK inside the community. Customary law governs protection inside the community, thus there is no need to accommodate intellectual property for that task.⁷⁵³ Rather the question is how custom-

⁷⁵² TK holders not only denounce vehemently the use and appropriation of their knowledge by private firms. They also criticize the documentation and publication of their knowledge by scientists and they reject the notion of public domain and research exception as being outside of their customary law. See for instance Tulalip Tribes of Washington (2003), *Statement on Folklore, Indigenous Knowledge, and the Public Domain* at the fifth session of the WIPO- IGC, July 09, in WIPO/GRTKF/IC/6/14

⁷⁵³ Ruth L. Okediji (2002), "Making Room at the Table..."

based innovation systems can be articulated within the existing framework of global intellectual property law.

Two reasons call for this articulation. One concerns the nature of customary law and difficulties of enforcement; the other is due to the important diversity among customary laws.

Regarding the nature of the regulation, customary laws of traditional communities like other social norms differ from law by their mechanism of enforcement. First, while violations of the law are monitored and punished by state actors, enforcement of social norms and customs is decentralized and carried out by private actors (peer supervision). This means that customary law enforcement is subject to collective action problems. Indeed, monitoring and punishment are public goods; they are costly to the punisher while the benefits are diffusely distributed among all participants⁷⁵⁴. Second, non-legal sanctions and reward mechanisms used to ensure compliance with customary law may not be sufficient.

In spite of these weaknesses, the regulation of traditional innovation by social norms or customary law has long been successful. It was facilitated by the relative isolation in which traditional communities have long lived; only a limited number of well acquainted ethnoscientists were interested in accessing their knowledge. The maintenance of informal regulations has become much more delicate as outsiders' interest for accessing traditional knowledge has grown and/or as the institutional environment – the CBD and patent laws – favors the appropriation of TK by third parties. These technological and legal changes can modify the incentives to comply with the provisions of customary law or social norms and induce members to disregard them (**internal defection**). As to third parties, they are not subjected to customary law and may behave in contradiction with the community's norms (**external defection**). In so doing, they further reduce their effectiveness. (*Cf. chapter four*). Therefore, we need to find a mechanism enabling TK holders to obtain protection for their knowledge against third parties in a way that helps them strengthen internal compliance with customary law.

The second reason for regarding the issue of customary law as a problem of articulation is the number of indigenous and local communities: each

⁷⁵⁴ Elinor Ostrom (1990), *Governing the Commons. The Evolution of Institutions for Collective Action*, Cambridge University Press, hereafter Elinor Ostrom (1990), *Governing the Commons* (...), p. 45 or Francesco Parisi (1999) "Spontaneous Emergence of Law: Customary Law" in Boudewijn Bouckaert and Gerrit De Geest (eds.) *Encyclopedia of Law & Economics*, <http://encyclo.findlaw.com/>

community has its own specific customary law adapted to the local context of innovation. The use of TK outside the community of origin requires other forms of protection; however, no attempt to replace customary law with a single piece of formal legislation will be able to accommodate the diversity of customary laws. The only solution might well be to find an institutional device to articulate customary laws to formal intellectual property law.

I have already described two possible solution and their limits. There might be an alternative that could be called “contracting into customary law” that would combine property rights, contract and possibly collective rights organization.

6.4 A Possible Solution: Formalizing Customary Law in Contracts

The main point is that TK holders need a property right that will be internationally recognized. This right would acts as a hinge or mediating mechanism between customary intellectual property law in force within the community and global intellectual property law that apply to relationships between the community and third parties. Once granted this right, TK holders can write licenses that embody the provisions of customary law and be in a position to enforce the provisions of customary law either for breach of license or infringement of their property right.

This solution has already been tested for other norms-based systems of innovation that have had to organize their articulation within the legal system of intellectual property.

In Part One, I explained that the norm of shared access regulating exchanges of knowledge among American academic scientists has been challenged by a series of legal changes allowing the patenting of basic research and therefore creating a legal environment where defecting members can appropriate or patent, their knowledge. To strengthen adhesion to the norm deemed essential to innovation, the community of academic biologists drafted a Uniform Biological Material Transfer Agreement (UBMTA) that embodies the community norm. At first the UBMTA had limited success because it was voluntary and there was no property right to enforce it or any organization in charge of enforcement. The results have been better since similar provisions have been introduced within the guidelines of the American National Institute of Health (the main fund provider for biomedical research) endowed with a (limited) capacity to enforce the norm.

The group of bilateral contracts between CGIAR centers and the FAO and their joint statement regulating ownership and conditions of access to their collection of genetic resources, and more recently the new international treaty on plant genetic resources are two attempts to formalize social norms by a combination of property rights and contracts (material transfer agreement) to preserve them in a changing institutional environment (IP law and CBD). (*Cf. part two, chapter five*)

The most complete example of such formalization is the well-known community of open-source software. It started as an innovation system regulated by a series of community norms that ruled what knowledge had to be shared among all members and what could be individually appropriated. The challenge is that this norms-based community is located in a legal environment where its knowledge (source code) can be appropriated by third parties or defecting members. The open-source community faced the same double threat as a community of TK holders: the vulnerability of their norms-based regime to both external and internal opportunism. One of the solutions adopted has been to obtain formal IPRs in order to draft and enforce licenses that allow third parties to use, modify and redistribute the knowledge so long as they respect the norms of the community embodied in the text of the license. If a user violates the license, he can be sued for either breach of the license or infringement of the copyright.⁷⁵⁵ In addition, to facilitate enforcement, rights are assigned to an organization representative of the community (the Free Software Foundation) that is in charge of legally enforcing the community norms.

I will now examine this proposal to formalize customary law in contracts in relation to databases. I suggested in the above discussion that databases might provide useful protection for TK. Once granted an internationally recognized property right, or equivalent form of control, TK holders are in a position to design and impose different regimes of access according to the provisions of customary law.⁷⁵⁶ Access can be given to different categories of knowledge, users (members vs. outsiders), different uses, like patent office searches of the prior art, research purpose, commercial use, etc.). Additionally, different levels of access can be granted (full access for research or partial access for prior

⁷⁵⁵ For more details see notably David McGowan (2001) "Legal Implications of Open-source Software" University of Illinois Law Review, vol. 2001, No1, pp. 241-304

⁷⁵⁶ Obviously TK holders willing to negotiate access to their knowledge against compensation are submitted to the law of supply and demand, if they raise the condition of access, demand is likely to go down

art searches or samples to potential users, etc).⁷⁵⁷ This is not at all a pure theoretical suggestion; several communities, including the North American Tulalip Indian tribes⁷⁵⁸ and the Kaska Traditional Knowledge network of British Columbia⁷⁵⁹ as well as the Indian databases mentioned in chapter 5 now envisage it.

What would be the legal effect of customary law? The situation is slightly more complicated because the best protection for databases consists of a combination of technological measures (conditional access technology) and/or a legal property rights (copyright and perhaps the E.U. *sui generis* right on databases). With conditional access technology, TK holders can more or less perfectly control access to the database. Once access has been granted, the use of the TK can be governed by licenses that include the provisions of customary law. Because licenses only rule relations between co-contracting parties, TK holders may combine technological measures with IPRs. In that case, third parties can be sued for infringement (Cf. section 5.4.1).

⁷⁵⁷ In the same sense the Asian Group notes that “*tiered levels of access authorization have been identified as a possible means for managing the intellectual property implications of establishing, using and partially publishing databases and registries of TK and associated biological/genetic resources*”. See WIPO (2002), Technical Proposals on Databases and Registries of Traditional Knowledge and Biological/Genetic Resources, WIPO/GRTKF/IC/4/14, p. 11

⁷⁵⁸ “*In the United States of America the Tulalip Tribes in Washington State are compiling a database of their traditional environmental knowledge named “StoryBase”*”⁷⁵⁸ While compiling this database, the tribes have distinguished between “Type A knowledge”, which they wished to reserve exclusively for the members of the tribal communities, and “Type B knowledge”, which the tribes wished to make available to the public at large. The software which is being developed to operate the database is being programmed to restrict access for Type A knowledge in the StoryBase to community members, whereas Type B knowledge will be disclosed and made available either to the general public or to patent examiners only. In distinguishing between Type A and Type B knowledge, intellectual property considerations are being taken into account and in the technical structure of the database this distinction will be reflected in the access privileges of different users. The access privileges are complex and are still being developed on the basis of discussions within the Tribes. However, the tribes have already identified three “core principles” that should be borne in mind as TK finds expanded use in policy making: tribes are sovereign; good law follows good practice; researchers should perform research in utmost good faith and respect for tribal traditions.” WIPO (2004) Update on Technical Standards and Issues Concerning Recorded Or Registered Traditional Knowledge WIPO/GRTKF/IC/7/7 page 319 .See also Tulalip Natural Resources. “Cultural Stories” ICONS CD-ROM. 2002. See entry in the Inventory contained in Annex II and Preston Hardison (2004) “Traditional Knowledge Studies and the Indigenous Trust.” Tulalip Tribes and the Indigenous Biodiversity Information Network (IBIN). September 15, (on file with the author).

⁷⁵⁹ CBD (2005), ...*The Advantages and Limitations of Registers*, p. 11

Finally, the database maker (either a community or third party acting as a collective rights organization managing the rights of different rights holders) (*Cf. section 5.4.2*) could be in charge of legally enforcing the customary law.

Conclusion and Further Developments

Synthesis

In this third part, I have followed my comparative and theoretical approach to reconstruct an historical account of the evolution of the property regime. The objective was not to write a history of the discussions on TK protection but rather to provide some clarity on the notion and evolution of TK and the conditions in which it is produced, used, conserved and exchanged.

From this analysis, it appears that the main issue consists of preserving and combining two functions of traditional knowledge. Traditional innovation is an autonomous system of innovation, in the sense that traditional innovators mainly innovate for the use of the members of their community, and the community rules that innovation. Traditional innovation has additionally become an upstream source of innovation for bio-industry. The challenge is to successfully combine these two functions.

In Chapter Two I identified a first equilibrium where one can distinguish the situation within communities and the outside. Within the community, the appropriation and the exchange of TK is ruled by customary law or social norms; the property regime of TK is a mix of individual and common property. *Vis-à-vis* third parties (not subject to customary law), TK appropriation and exchanges are unregulated; it appears to be in open-access. This situation is not too problematic as long as traditional innovation is fit and contacts between communities and third parties remain limited.

In Chapter Three I suggested that this equilibrium has been disrupted by a double change. The development of modern biotechnologies increases the potential value of TK for third parties (bio-industry) whereas simultaneously one observes an alarming erosion of traditional knowledge.

In Chapter Four I identified several difficulties that hinder attempts to combine the two functions of traditional innovation. First, it is difficult to transfer because of the tacit dimension of TK. Second, TK is difficult to conserve because of its tacit dimension (and because of lack of funding). In addition, the capacity of communities to self-regulate

traditional innovation is affected by the new possibility for appropriating raw TK or TK derived inventions which is an incentive to disregard the community norms or customary law, thus encouraging internal defection (appropriation and commercialization by community member) or external defection (appropriation by third parties).

In Chapter Five I provided a brief account of the current international negotiations on the definition of a possible intellectual property right for TK and their limits. Then, I examined a possible solution that is currently tested by some TK holders: the creation of TK databases and the integration of customary law provisions in contracts organizing the creation, the management and access to these databases. As for the definition of intellectual property rights to TK, I suggested to adopt a utilitarian approach looking at the nature of TK and the possible effects of the creation of property rights; it appears that the rationale for an intellectual property right is not so much the need of an exclusion mechanism but rather an incentive to codify knowledge in order to facilitate its transmission. It is therefore an argument for the creation of TK databases.

Regarding the coordination of knowledge and IPR exchanges, one solution envisaged by TK holders is to rely on their capacity to self-regulate and resort to coordination mechanisms more complex than the market. Where a single community or several communities of TK holders pool their knowledge into a database or a network of databases they will obtain a property right to this database. Then, using this property right and contract, they can set up an institutional arrangement so as to formalize customary law into force within the communities and reduce transaction costs. In so doing, they articulate their customary property regime within a formal legal system. An additional characteristic of this institutional arrangement is that it is likely to create or formalize a form of intermediary property regime (common property).

What lessons can we draw from this work? In this third part, I have argued that there are strong arguments in favor of the creation of TK databases and I have observed that several groups of TK holders have set up such databases. I have also stressed the importance of articulating customary laws organizing traditional innovation within formal international intellectual property law. I have suggested combining IPRs and contracts embodying the provisions of customary law and have observed that some communities envisage this possibility. It is now time to return to the process of creating TK databases and the future developments.

Assessing the Ongoing Movement of Databases Creations

In the late 1990s, an enthusiastic movement to create databases was initiated in several parts of the world; WIPO tried to bring its support by documenting and sharing experiences, by setting up a common gateway to access existing databases, by discussing the possibility of a common classification system for TK, and by articulating within the international patent classification. Unfortunately, ongoing experimentations with the creation of TK databases have been slowed down by criticism. I believe that a careful analysis can help to clear up these criticisms (*Cf. section 5.4*). It is difficult to foresee whether it will be enough to overcome the disagreement within the WIPO-IGC between proponents of databases lead by Asian countries, and the critics who are NGOs and indigenous communities mainly from South America. These critics are very cautious about the use and commercialisation of their knowledge by third parties.⁷⁶⁰

If one focuses on existing databases, it appears that their creation has been a success in documenting the concerned traditional knowledge. These databases have further helped to slow down the erosion of traditional knowledge. Interestingly, attempts to commercialise TK have not yet generated much success⁷⁶¹.

One reason might be the fragmentation among many different databases without unique classification systems and technical standards. Several initiatives have been taken to overcome these difficulties and create a network of databases. Another reason for the limited success of attempts to commercialize access to TK lies in the presence of high transaction costs. Again, the creation of a network of databases might be a convenient way to lower these transactions costs.

⁷⁶⁰ See the minutes of the World Intellectual Property Organization Intergovernmental Committee on Intellectual Property, Genetic Resources, Traditional Knowledge and Folklore. (However any community of TK holders is free to set up its own database or to pour its knowledge in an existing database without waiting the emergence of a consensus within WIPO-IGC)

⁷⁶¹ CBD (2005), *The Advantages and Limitations of Registers (...)*

Practical Futures Developments

Creating a Network of Databases...

Countries in favor of the creation of TK databases have taken some initiatives to overcome the current fragmentation of databases.

First, at the fourth session of the WIPO-IGC in December 2002, the Asian Group submitted a document entitled “*Technical Proposals on Databases and Registries of Traditional Knowledge and Biological/Genetic Resources*”⁷⁶². The Asian Group recommends the use of multi-purpose databases and registries, which serve both as defensive protection and as positive legal protection of TK and associated genetic resources. Then, the document highlights the need to adopt common technical standards to facilitate the consultation of databases and their interoperability (thus preparing their possible connection into a network of independent databases). The document identifies three categories of needed standards: (1) to facilitate the documenting of TK and consultation of databases, database makers need *content and resource identification standards* which specify how TK may best be described in the databases (including standardized data structures, metadata and system of correlation between vernacular names of local languages and science’s name); (2) to enable the interoperability of databases, they need *technological standards*; (3) if databases are protected by technological measures (conditional access systems), TK holders might need *security and transmission standards*, which specify how access to databases may be controlled and how data about TK and associated biological/genetic resources may be securely exchanged between databases and registries. The document contained a draft for such data specification. Based on the draft, the Asian Group proposed to develop an interregional consensus on the data specification.⁷⁶³

Second, without waiting for progressive discussions within the WIPO-IGC, Indian makers of TK databases have decided to take the initiative to create common classification and technical standards in order to network Indian databases, and may later be extended to other countries

⁷⁶² WIPO (2002), *Technical Proposals on Databases and Registries of Traditional Knowledge and Biological/Genetic Resources*, WIPO/GRTKF/IC/4/14

⁷⁶³ At the fifth session the WIPO-IGC “supported the proposal ..., including the transmission of it to the appropriate body within the Standing Committee on Information Technology (SCIT).” However, for the WIPO-IGC efforts consist merely in providing a forum for exchange of information on the ongoing progress and experiences of local, national and regional initiatives regarding recorded and registered TK.

databases⁷⁶⁴. The rationale for networking databases is two-fold: to facilitate their consultation by patent offices for potential users while maintaining their independence, which is deemed to be essential for the involvement of communities and the maintenance of traditional innovation.

Third, efforts are made to combine the need to create common classifications for TK and the need to facilitate consultation of TK databases by patent offices searching for evidence of prior art. A modern system of TK classification, the Traditional Knowledge Resources Classification (TKRC) has been created in India. TKRC identifies about 5,000 sub-groups of TK against one group in international patent classification (IPC), i.e. AK61K35/78 related to medicinal plants. The information is structured under section, class, sub-class, group and sub-group as per the International Patent Classification (IPC). It is organized in this manner for the convenience of its use by the international patent examiners. In turn, patent examiners have tried to integrate TK in the International Patent Classification. As a first step, WIPO set up a *Task Force on Classification of Traditional Knowledge* which developed a new main group for the IPC, designated A61K 36/00, with approximately 200 subgroups, in the field of medicinal preparations containing plants. This first adaptation of the IPC has been approved and entered into force in January 2006 more detailed classifications could be inserted after further work.⁷⁶⁵

Acting as a Collective Rights Organization...

High transaction costs constitute an important hindrance in the commercialisation of traditional knowledge. However, the creation of databases and even more the creation of a network of databases might be a convenient way to lower these transactions costs. This network of databases would act as a collective rights organization (CRO) lowering transaction costs. However, there would be an important difference with other CROs that I examined in this dissertation. In other cases, members of the CROs were in a symmetrical position: most members were both providers and users in turn. Members had the same incentives to create a

⁷⁶⁴ Madhav Gadgil (2004) Report of the Workshop on Networking of Biodiversity Databases held at the Centre for Ecological Sciences, during March 23rd to 24th available at <http://webis.ces.iisc.ernet.in/biodiversity/Network/network.htm>

⁷⁶⁵ See WIPO (2003), *Defensive Protection Measures Relating to Intellectual Property, Genetic Resources and Traditional Knowledge: An Update*, WIPO/GRTKF/IC/6/8 and WIPO (2004), *Development of Classification Tools for Traditional Knowledge*, WIPO/IPC/CE/34/8

CRO that facilitated exchanges between themselves; they could even consider creating a zone of shared access among them. By contrast, this CRO would only gather one party: TK holders. In this sense, the network of databases could be compared with copyright collectives, which reduce search costs by offering a single “ticket office”, lower bargaining costs by proposing standard licences and centralize monitoring and enforcement. Indian makers of TK databases are currently considering this possibility at the national level.⁷⁶⁶

Search costs designate the costs of locating an exchange partner, that is to say identifying a person who wants to sell what you want to buy or buy what you want to sell. Today, high search costs hinder access to and use of traditional knowledge. Traditional knowledge is not a standard good with well-identified characteristics and well-known sellers. The use of traditional knowledge to identify interesting genetic resources in hope of developing a commercial product gives unpredictable results. In addition, TK holders know little of the needs of potential users and TK users dispose of little information on who has what to sale. Reducing the costs of searching relevant information is precisely the purpose of databases. However, the scattering of TK in many different databases without unique classification systems and technical standards hinders this reduction of search costs. The creation of a network of TK databases consultable through a single gateway where TK is well documented and arranged under a common classification, with a cadastre identifying precisely who holds what knowledge and what property rights might reduce, drastically search costs.⁷⁶⁷

Monitoring and Enforcement costs include the costs of monitoring behaviors and sanctioning infringements of property rights as well as

⁷⁶⁶ They consider that negotiation, maintenance and enforcement of rights should be ensured by a single organization. This organization would interact with the knowledge holders, either individuals or communities through the medium of Memoranda of Agreements (MOA). Such MOAs would take place of the generally recommended PIC (Prior Informed Consent), since the PIC is a one-way transaction and does not incorporate an element of reciprocal responsibility on part of the agency receiving the information. The organization would interact with users through standard information transfer agreements. See Madhav Gadgil (2004) Report of the Workshop on Networking of Biodiversity Databases held at the Centre for Ecological Sciences, during March 23rd to 24th available at <http://wgbis.ces.iisc.ernet.in/biodiversity/Network/network.htm>

⁷⁶⁷ To some extent the creation of databases can be compared to the creation of *ex situ* collections of genetic resources with the advantages of good classification system and easy access. The possibility to create a network of independent TK databases enables to combine the advantage of *ex situ* conservation (classification, facilitated use) and the advantage of *in situ* conservation (ongoing evolution)

breaches of contract. Monitoring the use of TK is difficult because it involves tracking the use of some information through the R&D chain. In many situations, identifying whether or not some TK is at the origin of a commercial product is a very delicate task. Then, once an invention is made and commercialized, it is costly for TK holders to verify the extent of the commercial success, which implies knowing the level of sales and all the costs that contribute to developing and selling the products. The creation of a database and even more the creation of a network of databases can reduce the costs of monitoring uses of TK and enforcing property rights and contracts if it includes the designation of someone⁷⁶⁸ in charge of these functions. First, members can benefit from economies of scale if monitoring and enforcement involve fixed costs that can be shared. Second, specialization enables the designated enforcer to perform this task more efficiently.

Bargaining costs designate the costs of reaching an agreement. Among many others (*Cf. infra*), the number of involved parties may be an important source of bargaining costs. Companies interested in using traditional knowledge may want to consult all the available TK on a precise group of plants rather than all the knowledge of a certain community. Therefore, they will need to negotiate access with a large number of communities with different conditions of access, which might be a costly process in comparison to the value of the concerned TK.

TK holders setting up a network of databases could consider drafting standard licenses. It could offer economies of scale in the design of rules: as there are many redundancies in contracts ruling exchanges of property rights (licenses), mandatory or optional standard contractual provisions allow parties to negotiate only a limited number of issues. However, two qualifications must be made. First, drafting standard contracts might run counter to the objective of respecting the diversity of customary laws. TK holders may have to make a trade-off between these two objectives. One possible solution might be to draft a series of standard licences covering the main situations: different types of knowledge, different categories of users and different types of uses. Then, according to their customary law, TK holders could designate what knowledge is accessible under what licence. Second, those standard contracts would in fact be standard offers drafted only by one party: TK providers. TK users still need to accept them.

⁷⁶⁸ For instance, in the project mentioned above of creating a network of Indian databases they plan to entrust a single organization (probably the National Innovation Foundation) with the negotiation, maintenance and enforcement of rights.

The difficulty is that indigenous and local communities have to cope with imperfect information. They have little information on the potential uses of their knowledge, on the costs of R&D, and on possible alternative sources of information. In addition, they do not know whether the disclosure will, amongst other things, be treated in a way that is consistent with their cultural values and goals. They face the possibility that they will conclude *ex post* that their integration into biodiversity commerce was not worth the resulting changes to their traditional social world.⁷⁶⁹ As a result, TK holders might be tempted to impose a host of mandatory conditions on parties wishing to make use of their traditional knowledge. It is open to question, however, whether this would serve the interests of industry or those of the indigenous and local communities. If the conditions prove too onerous, companies will not invest in utilising traditional knowledge. This is precisely what happened with ABS legislation implementing the CBD that I described in Part Two. This result would be inefficient.⁷⁷⁰

Run by Both Providers and Users?

To deal with this issue, a further stage might be useful. It is in that spirit, that Professor Peter Drahos has suggested the creation of a “global biocollecting society” **run by both users and providers**.⁷⁷¹ This biocollecting society could negotiate standard contracts acceptable for both parties. As I mentioned earlier, this sort of collective rights organization gathering both providers and users can also include collective valuation mechanisms that are more efficient than bilateral (market) valuation when there are important information asymmetries (information about the threat values and the bargaining surplus is private). Collective valuation by a CRO can also be more efficient than legislative or judicial liability rules: valuation is more customized because members have more expertise than legislators and judges; valuation is more responsive because valuation rules can be modified much more quickly than

⁷⁶⁹ Peter Drahos (2000), “Indigenous Knowledge, Intellectual Property and Biopiracy: is a Global Bio-Collecting Society the Answer?”, 22 EUROPEAN INTELLECTUAL PROPERTY REVIEW, 245-250

⁷⁷⁰ *Ibidem*

⁷⁷¹ *Ibidem*. Note that the proposal of Peter Drahos was not connected with the creation of a network of TK databases. The difference is important. As I mentioned above, firms rarely access TK directly. Most often, they use codification of TK made by academics. If TK holders undertake to codify themselves their knowledge and to create databases, then there might be more direct contact between TK holders and firms interested in using their knowledge.

legislation. This bio-collecting society may also be useful to overcome cultural differences or the lack of trust that complicates the search for mutually agreed upon terms⁷⁷². Last, this bio-collecting society could include alternative dispute resolution mechanisms that might increase the level of trust among the parties and lower enforcement costs. The idea would be that the bio-collecting society would stimulate a process of self-regulation amongst companies and TK holders.⁷⁷³

To sum up, it seems that the creation of a network of interconnected databases with common classification systems and common technical standards could facilitate access to traditional knowledge and benefit sharing. As an additional step, the network of databases could act as a collective rights organization acting on behalf of TK holders based on the model of copyright collectives to reduce transaction costs. A third stage might be the creation of processes of self-regulation amongst TK holders and users including a mechanism of collective valuation and the negotiation of standard contracts acceptable by both parties.

These mechanisms could enhance the welfare of both TK holders and users by reducing transaction costs. However, it does not mean that they will automatically emerge. TK holders and users are far from being a community with internal characteristics identified by Elinor Ostrom and others as favourable to the emergence of collective rights organizations and/or other forms of self-regulation. Beyond, their attempts to create new property rights, WIPO and other intergovernmental organizations dealing with traditional knowledge protection might consider how they could facilitate the emergence of such mechanisms.

⁷⁷² For some testimonies on the “environment of suspicion”, see Rex Dalton (2004), “Bioprospects...”, p. 598 or Ten Kate and Laird (1999), *The Commercial Use of Biodiversity*, p. 296

⁷⁷³ Peter Drahos (2000), “Indigenous Knowledge, ...”

General Conclusion

In view of the utility and the erosion of biodiversity and traditional knowledge, the new property regime initiated by the Convention on Biological Diversity aims at conserving and providing access to these inputs of innovation so as to ensure innovation in bio-industries for today and tomorrow.

The objectives of this dissertation were: (i) the identification and description of the solutions that have been tested or discussed; (ii) an assessment of whether these solutions fulfill (or are likely to fulfill) the objectives and an identification of their limits (iii) an explanation of the causes of these limits, (iv) and suggestions for possible solutions.

To fulfill these objectives, I adopted a **comparative and theoretical approach** and I examined whether the discussions on genetic resources and traditional knowledge were examples of broader phenomena that have already been observed and theorized. Because the solution considered by the Convention on Biological Diversity consists of granting exclusive rights as an incentive to conserve pieces of useful information (biodiversity and traditional knowledge), I turned to the branch of law that typically regulates the production and use of knowledge, i.e. intellectual property law.

Accordingly, in the first part of this dissertation, I use the work of a group of law and economics scholars to reconstruct an historical account of the evolution of the intellectual property system and the evolution of its underlying economic theories. The function of the first part is twofold. First, it provides me with a theoretical framework to look at genetic resources and traditional knowledge issues. Second, it highlights important analogies between the evolution of the system of intellectual property, the property regime of genetic resources and the discussions on traditional knowledge; the three parts of the dissertation are written like three parallel histories.

Very schematically, this comparative and theoretical approach highlights the following common issues, common engines of change, and common institutional solutions.

The first common issue concerns the provision of public goods. Because knowledge is a public good, the market alone will not provide sufficient

quantities of it. The difficulty comes from two characteristics of public goods –non exclusiveness and non-rivalry– that call for contradictory measures. Non-exclusiveness calls for the creation of an exclusionary mechanism to internalize the benefits of the provision of public goods, whereas non-rivalry suggests that knowledge should be freely available. These contradictory characteristics create the knowledge dilemma that is often resolved by a two-part balance. The first part of the balance consists of identifying the best mix of two solutions to produce knowledge: the creation of temporary exclusive rights to knowledge or public financing of knowledge production. Knowledge production can be seen as an innovation chain. Classically, public provision is used for the first stages of the chain, the upstream part; while IPRs are used for the last stages of the chain, the downstream part. The second part of the balance concerns the definition of intellectual property rights: the conditions for protection must identify intellectual achievement for which the benefits of the incentive effect produced by IPRs will exceed the costs (society is prevented from practicing the invention and using it as an input to future discoveries without permission from the inventor).

However, this two-part balance is provisional and could be disrupted by a series of changes. Changes are partly due to the evolution of the technological context that modifies the costs and benefits of creating and enforcing property rights. They may also come from amendments within the innovation and conservation policies. Those changes may elicit new issues both for economic agent and scholars.

A second issue common to the three parts becomes as important as the provision of public goods: the need to coordinate exchanges of knowledge and property rights. The first solution for the coordination of knowledge and IPRs exchanges consists of relying on the market. However, due to important transaction costs, it quickly becomes clear that the market alone may not always ensure an efficient coordination of knowledge and IPR exchanges. One possible solution is to resort to government intervention to overcome transaction failure. This possibility can be examined in light of the entitlement theory initiated by Calabresi and Melamed. Another solution, in certain circumstances, involves economic agents setting up institutional arrangements that reduce transactions costs and facilitate exchanges; a careful observation reveals the presence of a multitude of scenarios involving self-regulation that are

articulated with the formal legal system. These self-regulatory experiences can be examined in light of new institutional economics⁷⁷⁴.

Hopefully, this dissertation offers a valuable contribution to the discussions on biodiversity and traditional knowledge. The primary and general contribution is to offer some clarity to an oft confused topic. A secondary contribution is to provide some guidance to the ongoing discussions.

Regarding the definition of property rights, especially on traditional knowledge, this dissertation suggests a reasoning to design well-defined property rights. It suggests a detailed solution for at least a part of TK (ethnobotanical knowledge), and supports TK holders that are undertaking valuable experiences by setting up databases to protect traditional knowledge.

This dissertation highlights the growing importance of a major issue: the coordination of exchanges of knowledge and the role of transaction costs in intellectual property regimes in general and in particular in the property regimes of genetic resources and traditional knowledge. In a context of collective and cumulative innovation, one has to consider not only the relationship between the producer and the consumer, but also the relationship between the producer and its competitor, and the relationship between owners of complementary pieces of knowledge that must be combined to develop a final product. Highlighting this new issue helps to examine the role of the state (law) in the reduction of transaction costs either by designing the most efficient property right or by solving individual transaction failures by *ad hoc* intervention (compulsory licenses). Above all, it helps to capture the importance of forms of self-regulation through which economic agents might modify their rights in order to adapt to the specificities of their technological context. These self-regulatory mechanisms may reduce transaction costs as between the parties, and create new forms of property regimes, aside from the usual opposition between the public domain and individual private property.

I believe that if participants and observers of the discussions on genetic resources and traditional knowledge were more aware of this new issue, they would consider more effective solutions. In addition, they would

⁷⁷⁴ Note that if the new-institutional economics has recently been integrated in IPR scholarship to examine experiences of self-regulation, in the broader literature on governance there are other theoretical models to analyze institutional mechanisms to frame the market.

take note of practical experiences in which economic agents try to create or adapt property regimes tailored to the characteristics of their activities. These practical experiences are worth looking at for three reasons. First, practical experiences can be valuable sources of inspiration for international law makers. Second, if international negotiators want to anticipate the future effects of the regime they are negotiating, they should be aware of how economic agents are likely to modify the rights they are granted. Third, efficient solutions to foster the conservation, use and exchange of genetic resources and traditional knowledge are likely to be situations that articulate law and forms of self-regulation.

This dissertation also calls for future work. Intellectual property scholarship has made important progress in relaxing its legal or state-centric view of appropriability and its illusionary belief in the efficiency of the only market-like form of decentralization. Further, Intellectual property scholarship has made progress in observing that self-regulation may make an important contribution to defining property regimes and regulating exchanges of knowledge. This work should be continued by further integrating lessons of the literature on self-regulation and “co-regulation” into intellectual property scholarship, and simultaneously documenting emerging experiences in the field of intellectual property, genetic resources and/or traditional knowledge.

Bibliography

Adair, John R. (1997) "The Bioprospecting Question: Should the United States Charge Biotechnology Companies for the Commercial Use of Public Wild Genetic Resources?", 24 *ECOLOGY LAW QUARTERLY* 131

Agarwal, A. and S. Narain (1996) "Pirates in the Garden of India", *NEW SCIENTIST*, October 26

Aguilar, Grethel (2001) "Access to Genetic Resources and Protection of Traditional Knowledge in the Territories of Indigenous Peoples, 4 *ENVIRONMENTAL SCIENCE & POLICY* 241-256

Alexander, Merle *et al.* (2003), *The role of Registers & Databases in the Protection of Traditional Knowledge, a Comparative Analysis*, United Nations University Institute of Advanced Studies

Allen, Robert C. (1983) "Collective Innovation", 4 *JOURNAL OF ECONOMIC BEHAVIOR AND ORGANIZATIONS* 1

Anaya, S. James (1996), *Indigenous Peoples in International Law*, New York – Oxford: Oxford University Press

- Andersen, Regine (2003), "FAO and the Management of Plant Genetic Resources", in Olav Schram Stokke and Øystein B. Thommessen (eds.), *Yearbook of International Cooperation on Environment and Development 2003/2004*, London: Earthscan Publications, pp. 43-53
- Anderson Jane (2004), "The Politics of Indigenous Knowledge: Australia's Proposed Communal Moral Rights Bill" 27 UNIVERSITY OF NEW SOUTH WALES LAW JOURNAL 585
- Anuradha R.V., Taneja B. and Kothari A. (2001) *Experiences with Biodiversity Policy Making and Community Registers in India*, London: International Institute for Environment and Development (IIED) and Earthprint Ltd
- Anuradha, RV, Taneja, B, and Kothari, A. (2001), *Experiences with Biodiversity Policy-making and Community Registers in India*, International Institute for Environment and Development (IIED) Biodiversity and Livelihoods Group. ABS case study no. 3.
- Arrow, Kenneth J. (1962), "Economic Welfare and Allocation of Resources for Innovation", in Richard R. Nelson (ed.), *The Rate and Direction of Inventive Activity: Economic and Social Factors*, Princeton: Princeton University Press
- Atkinson Richard C. *et al.* (2003), "Public Sector Collaboration for Agricultural intellectual Property Management" 301 SCIENCE 174
- Axelrod, Robert (1984), *The Evolution of Cooperation*, New York: Basic Books
- Arora, Ashish and Robert P. Merges (1999), "Intellectual Property Rights, Input Markets, and the Value of Intangible Assets", draft paper available at <http://www.law.berkeley.edu/institutes/bclt/pubs/merges/>
- Axt Jr, Corn M, Lee M and Ackerman DM (1993) *Biotechnology, Indigenous peoples and intellectual Property Rights*, Washington DC: Congressional Research Service, Library of Congress
- Ayres, Ian & Eric Talley (1995), "Solomonic Bagaining: Dividing a Legal Entitlement to Facilitate Coasean Trade", 104 THE YALE LAW JOURNAL 95
- Balick, Michael (1990), "Ethnobotany and the Identification of Therapeutic Agent From The Rainforest", *Bioactive Compounds from Plants*, Ciba Foundation Symposium p. 26-28.
- Barber, C.V. and A.G.M. La Viña (1997) "Regulating Access to Genetic Resources: The Philippines Experiences" p.115-141 in J. Mugabe, C.V. Barber, G. Henne. L. Glowka and A. La Viña (eds.) *Access to Genetic Resources*, Nairobi Kenya: WRI, ELC-IUCN, ACTS Press,
- Barber, Charles, LGlowka, and A La Viña (2001), "Developing and implementing national measures for genetic resources access regulation and benefit sharing" in S. Laird (ed), *Equitable Partnerships in Practice: Research and Commercial Use of Biodiversity and Traditional Knowledge*, London: WWF- UNESCO, Earthscan Publications
- Barsh, Russel L. (1999), "Indigenous Knowledge and Biodiversity, in Indigenous Peoples, Their Environments and Territories", in Darrel A. Posey (ed.) *Cultural and Spiritual Values of Biodiversity*, IT Publications & UNEP
- Barsh, Russel L. (2001), "Who Steals Indigenous Knowledge?" 95 AMERICAN SOCIETY OF INTERNATIONAL LAW PROCEEDINGS, 153
- Barton, John H. (2000), "Reforming the Patent System", 287 SCIENCE 1933-1934

- Barton, John H., (2004), "Preserving the Global Science and Technological Commons"
- Barzel, Yoram (1997), *The Economic Analysis of Property Rights*, Cambridge: Cambridge University Press, 2nd ed.
- Bastid, S. (1973) "L'état du droit international public en 1973 ", JOURNAL DU DROIT INTERNATIONAL 5-21
- Bath, Ulrika (2002), "Access to Information v. Intellectual Property Rights", 24 EUROPEAN INTELLECTUAL PROPERTY REVIEW 138-146
- Bellivier, Florence and Christine Noiville (2006), *Contrats et Vivants*, Paris: L.G.D.J.
- Benavidez II, Paz J. (2004), "Philippines: Evolving Access and Benefit Sharing Regulations", in Santiago Carrizosa *et al.* (eds.) *Accessing Biodiversity and Sharing the Benefits: Lessons from Implementing the Convention on Biological Diversity*, IUCN Environmental Policy and Law Paper, No 54, Gland, Switzerland
- Bensen S. M. & L. J. Raskind, "An introduction to the Law and Economics of Intellectual Property", 5 JOURNAL OF ECONOMIC PERSPECTIVES 3-27
- Bérard, Laurence *et al.* (2005), *Biodiversité et savoirs naturalistes locaux en France*, Paris: Cirad, Iddri, Ifb, Inra
- Bergmans, Bernard (1991), *La protection des innovations biologiques - Une étude de droit comparé*, Bruxelles : Larcier
- Besen, Stanley M., Sheila N. Kirsby & Steven C. Salop (1992), "An Economic Analysis of Copyright Collectives", 78 VIRGINIA LAW REVIEW 383
- Bessy & Brousseau (1998) "Technology Licensing Contracts: Features and Diversity" 18 INTERNATIONAL REVIEW OF LAW AND ECONOMICS 451
- Black, Julia (1996) "Constitutionalising Self-Regulation", 59 MODERN LAW REVIEW 24-55
- Blakeney, Michael (1997), "Bioprospecting and the Protection of Traditional Medical Knowledge of Indigenous Peoples: an Australian Perspective", 19 EUROPEAN INTELLECTUAL PROPERTY REVIEW 298-303
- Blakeney, Michael (2000), "The protection of Traditional Knowledge under Intellectual Property Law", 22 EUROPEAN INTELLECTUAL PROPERTY REVIEW 251-261
- Blakeney, Michael (2002), "Protection of Plant Varieties and Farmers' Rights", 24 EUROPEAN INTELLECTUAL PROPERTY REVIEW 9-19
- Boisvert, Valérie and Emmanuelle Caron (1998), "Biodiversity and Property Rights: The Contributions of a Neo-institutional Approach", Second International Conference of the European Society for Ecological Economic 4th-7th March, University of Geneva, Switzerland
- Boisvert, Valérie and Armelle Caron (2002), "The Convention on Biological Diversity: an Institutional Perspective", 36 JOURNAL OF ECONOMIC ISSUES 151
- Boisvert, Valérie & Franck-Dominique Vivien (2005), "The convention on Biological Diversity: A Conventionalist Approach", 53 ECOLOGICAL ECONOMICS 461- 472
- Bonneuil, Christophe (2001), "L'empire des plantes", 62 COURRIER DE LA PLANÈTE 6

- Bontems Philippe & Gilles Rotillon (2003), *L'économie de l'environnement*, Paris: La Découverte, "Repères"
- Bostyn, Sven J. R. (2002), "European Perspective on the Ideal Scope of Protection and the Disclosure Requirement for Biotechnological Inventions in a Harmonised Patent System; The Quest for the Holy Grail?", 5 JOURNAL OF WORLD INTELLECTUAL PROPERTY 1013
- Boyle, James (1996), *Shamans, Software, & Spleens: Law and the Construction of the Information Society*, Cambridge (Massachusetts), London, (Great-Britain): Harvard University Press
- Boyle, James (1997), "A Politics of Intellectual Property: Environmentalism for the Net?", 47 DUKE LAW JOURNAL 87–116.
- Boyle, James (2000), "Crucial, Mean or Lavish? Price Discrimination, and Digital Intellectual Property" 53 VANDERBILT LAW REVIEW 2007
- Boyle, James (2002) "Fencing off Ideas: Enclosure and the Disappearance of the Public Domain", 131 DAEDALUS 13
- Boyle, James (2003), "Foreword: The opposite of Property", 66 LAW AND CONTEMPORARY PROBLEMS 1
- Boyle, James (2003), "The Second Enclosure Movement and the Construction of the Public Domain", 66 LAW AND CONTEMPORARY PROBLEMS 33
- Bragdon, Susan (ed.) (2004), "International Law of Relevance to Plant Genetic Resources: A Practical Review for Scientists and Others Professionals Working With Plant Genetic Resources", ISSUES IN GENETIC RESOURCES No.10
- Brahy, Nicolas & Sélim Louafi (2004), "La Convention sur la Diversité Biologique à la croisée de quatre discours", Rapport de l'Iddri n° 4
- Brousseau, Eric and Christian Bessy (2005), "Public and Private Institutions in the Governance of Intellectual Property Rights", in B. Andersen (ed.), *Intellectual Property: Innovation, Governance and the Institutional Environment*, Edward Elgar Publisher
- Brousseau, Eric, M'hand Fares and Emmanuel Raynaud (2004) "The Economics of Private Institutions, paper presented at the 8th Annual Conference of the New Institutional Economics, "Institutions and Economic and Political Behavior", September 30-October 4, 2004 Tucson Arizona, USA
- Brown K.M. (1998), *Downsizing Science*, Washington D.C.: The AEI Press
- Brush, Stephen B. (1993), "Indigenous knowledge of biological resources and intellectual property rights: the role of anthropology", 95 AMERICAN ANTHROPOLOGIST 653-686
- Brush, Stephen B. (1996) "Is Common Heritage Outmoded?" in Stephen Brush and Doreen Stabisky (eds) *Valuing Local Knowledge. Indigenous peoples and intellectual property Rights*, Washington D.C.: Island Press
- Brush, Stephen B. (1999), "Bioprospecting the Public Domain", 14 CULTURAL ANTHROPOLOGY 535
- Brush, Stephen B. (2000), *Genes in the Field: On-Farm Conservation of Crop Diversity*, Ottawa and Rome: IPGRI/IDRC/ Lewis Publishers

Brush, Stephen B. (2003), "Farmer's Rights and Protection of Traditional Agricultural Knowledge", paper presented at the CAPRI/IPGRI International Workshop on Property Right, Collective Action and Local Conservation of Genetic Resources, Rome, September 29th-October 2nd

Brush, Stephen B. (2005), "Protecting Traditional Agricultural Knowledge" 17 WASHINGTON UNIVERSITY OF LAW AND POLICY 59

Brush, Stephen B. and Dorren Stabinsky (eds), (1996), *Valuing Local Knowledge, Indigenous Peoples and Intellectual Property Rights*, Washington D.C.: Islands Press

Buchanan, James M. & Yong J. Yoon (2000), "Symmetric Tragedies: Commons and Anticommons", 43 JOURNAL OF LAW AND ECONOMICS 1-13

Bullard, Linda (2005) *Freeing the Free Tree: A Briefing Paper on the First Legal Defeat of a Biopiracy Patent: The Neem Case*, Research Foundation for Science, Technology and Ecology, New Delhi, India International Federation of Organic Agriculture Movements The Greens/European Free Alliance in the European Parliament, available at http://www.ifoam.org/press/press/pdfs/Briefing_Neem.pdf

Burhenne-Guilmin, Françoise (1998), "L'accès aux ressources génétiques: les suites de l'article 15 de la Convention sur la Diversité Biologique" in Michel Prieur et Claude Lambrechts (eds.) *Les Hommes et L'Environnement, Quels droits pour le vingt-et-unième siècle ? Etudes en Hommages à Alexandre Kiss*, Paris: Frison-Roche

Business India (2004) "Digital Library for Traditional Knowledge in SAARC region", New Delhi, 27 December

Buydens, Mireille (1993), *La protection de la quasi-crédation*, Bruxelles: Larcier-Bruylant-FEC

Buydens, Mireille (1999), *Droit des brevets d'invention et protection du savoir-faire*, Bruxelles: Larcier

Cabrera Medaglia J. (2004), "Bioprospecting Partnerships in Practice: A Decade of Experiences at INBio in Costa Rica" 11 IP STRATEGY TODAY 27-40

Caffagi, Fabrizio (2004), "Le rôle des acteurs Privés dans les processus de régulation: participation, autorégulation et régulation privée" 109 REVUE FRANÇAISE D'ADMINISTRATION PUBLIQUE 23-36

Caillaud, Bernard (2003), "La propriété intellectuelle sur les logiciels ", Rapport du Conseil d'Analyse Economique, Paris: La documentation française

Calabresi, Guido & A. Douglas Melamed (1972), "Property Rules, Liability Rules, and Inalienability: one View of the Cathedral", 85 HARVARD LAW REVIEW 1089

Callon, Michel (1994), "Is Science a Public Good?", 19 SCIENCE, TECHNOLOGY AND HUMAN VALUES 4, 395

Callon, Michel & Dominique Foray (1997), "Nouvelle économie de la science ou socio-économie de la recherche scientifique ? ", 79 REVUE D'ECONOMIE INDUSTRIELLE 13-32

Cantuaria Marin, Patricia Lucia (2002), *Providing Protection for Plant Genetic Resources. Patents, Sui Generis Systems, and Biopartnerships*, New York, The Hague and London: Kluwer Law International,

Carrizosa, Santiago et al. (eds.) Accessing Biodiversity and Sharing the Benefits: Lessons from Implementing the Convention on Biological Diversity, IUCN Environmental Policy and Law Paper, No 54, Gland, Switzerland

Carvalho, Nuno P. (2000) "Requiring Disclosure of Origin of Genetic Resources and Prior Informed Consent in Patent Applications without Infringing the TRIPS Agreement/ The Problem and the Solution" 2 WASHINGTON UNIVERSITY JOURNAL OF LAW AND POLICY 371

Cassidy M. and Langford J. (eds), (1999) *Intellectual Property and Aboriginal People*, a Working Paper Ministry of Indian Affairs and Northern Development, Ottawa, Canada. Submitted for the UNCTAD Expert Meeting on Systems and National Experiences for Protecting Traditional Knowledge, Innovations and Practices, Geneva, 30 October - 1 November 2000

Cassier Maurice (2000), "Génopoles: quel modèle d'innovation?", 201 BIOFUTUR 20-21

Cassier Maurice (2002) "L'appropriation des connaissances dans les partenariats de recherche entre laboratoires publics et entreprises: quelques tendances récentes", Working Paper IMRI

Cassier Maurice & Dominique Foray (1999), "La régulation de la propriété intellectuelle dans les consortiums de recherche : les types de solutions élaborées par les chercheurs ", 52 ECONOMIE APPLIQUEE 155-182

Cassier Maurice & Jean-Pal Gaudillière (2000), "Les relations entre science, médecine et marché dans le domaine du génome: pratiques d'appropriation et pistes pour de nouvelles régulations: le cas de la génétique du cancer du sein", Working Paper de l'IMRI

CBD (2005), Composite Report on the Status and Trends Regarding the Knowledge and Practices of Indigenous and Local Communities. The Advantages and Limitations of Registers, UNEP/CBD/WG8J/4/INF/9/

CBD (2005) The Revised Phase One and Phase Two of the Composite Report on the Status and Trends Regarding the Knowledge, Innovations and Practices of Indigenous and Local Communities Relevant for the Conservation and Sustainable Use of Biological and Sustainable Use of Biological Diversity: Executive Summary and Recommendations, UNEP/CBD/WG8J/4/4

CBD (2006) Report of the Eighth Meeting of the Parties to the Convention on Biological Diversity, UNEP/CBD/COP/8/31

Centre de Droit de l'Entreprise (1975), *Le Know-how*, 5e rencontre de propriété industrielle, Montpellier

Cervantes Mario, "Introduction: Public/private partnerships in Science and technology", SCIENCE, TECHNOLOGY AND INDUSTRY REVIEW, n°23

CGIAR, The CGIAR History by itself available at www.cgiar.org/history.htm

Chaire Arcelor (2003), *Séminaire Brevet et Biotechnologies : rapport de synthèse des séminaires*, Louvain-la-Neuve

Chaire Arcelor (2003), *Séminaire Brevet & Logiciels: rapport de synthèse*, Louvain-la-Neuve

Chaire Arcelor (2003), *Séminaire Brevets et Créations commerciales: rapport de Synthèse*, Louvain-la-Neuve

- Chandler, Anupam and Madhavi Sunder (2004), "The Romance of the Public Domain" 92 CALIFORNIA LAW REVIEW 1331
- Chapman J.L. & M.J. Reiss (2001), *Ecology, Principles and Application* (2nd ed.), Cambridge: Cambridge University Press
- Charles, Daniel (2001) "Seeds of Discontent", 294 SCIENCE 772
- Charles E. Smith (1984) "Comment: Requirement for Patenting Chemical Intermediates: Do they accomplish the Statutory Goals?" 29 SAINT LOUIS UNIVERSITY LAW JOURNAL 191
- Chen, Jim (2004), "Webs of Life: Biodiversity Conservation as a Species of Information Policy", 89 IOWA LAW REVIEW 495
- Chen, Jim (2005), "Across the Apocalypse on Horseback: Imperfect Legal Responses to Biodiversity Loss", 17 WASHINGTON UNIVERSITY JOURNAL OF LAW AND POLICY 12
- Chen, Jim (2005), "Biodiversity and Biotechnology: A Misunderstood Relation", 2005 MICHIGAN STATE LAW REVIEW 51
- Chen, Jim (2005), "There is no Such Thing as Biopiracy... and it is a Good Thing Too", 36 MC GEORGE LAW REVIEW 2
- Chen, Jim (2006), "The Parable of the Seeds: Interpreting the Plant Variety Protection Act in Furtherance of Innovation Policy" 81 NOTRE DAME LAW REVIEW 4
- CIEL (1999) Comments on Improving Identification of Prior Art Recommendations on Traditional Knowledge Relating to Biological Diversity, Submitted to the United States Patent and Trademark Office August 2
- Lynch, Owen J. and Emily Harwell, (2002), Whose Natural Resources? Whose Common Good? Towards a New Paradigm of Environmental Justice and the National Interest in Indonesia, Jakarta: CIEL
- Clark, Jeanne *et al.*, (2001), "Patent Pools: A solution to the Problem of Access in Biotechnology Patents?", 20 BIOTECHNOLOGY LAW REPORT 607-622
- Cleveland David A. and Stephen C. Murray (1997) "The World's Crop Genetic Resources and the Rights of Indigenous Farmers, 38 CURRENT ANTHROPOLOGY 477
- Coase, Ronad H. (1960), "The Problem of Social Cost", 3 JOURNAL OF LAW & ECONOMICS 1
- COICA (1999), Biodiversidad, Derechos Colectivos y Régimen Sui Generis de Propiedad Intelectual, Quito:COICA-OMAEREOPIP
- Colin, Isabelle (1999), *Le génie génétique*, Paris: Milan
- Collombon, Jean-Marie (1983), in Philippe Khan & Jean-Claude Fritz (eds) *La Gestion des Ressources Naturelles d'Origine Agricole*, Paris : Librairie Technique
- Columbia University School of International and Public Affairs (1999), "Access to Genetic Resources: An Evaluation of the Development and Implementation of Recent Regulation and Access Agreements", Environmental Policy Studies Working Paper #4
- Committee on Intellectual Property Rights, Computer Science & Telecommunications Board (Samuelson P.) (2000), "The Digital Dilemma: A Perspective on Intellectual Property in the Information Age"

Coombe, Rosemary J. (2001), "The Recognition of Indigenous Peoples' and Community Traditional Knowledge in International Law", 14 ST. THOMAS LAW REVIEW 275

Coombe, Rosemary J. (2005), "Protecting Cultural Industries to Promote Cultural Diversity: Dilemmas for International Policy-making Posed by the Recognition of Traditional Knowledge" in Keith E. Maskus and Jerome H. Reichman (eds.) (2005) *International public Goods and Transfer of Technology Under a Globalized Intellectual Property Regime*, Cambridge: Cambridge University Press

Cooper (1976), "Patent Problem for Chemical Researchers-- The Utility Requirement After *Brenner v. Manson*", 18 IDEA 23

Cooter, Robert (1982), "The Cost of Coase" 11 JOURNAL OF LEGAL STUDIES 1

Cooter, Robert and Thomas Ulen (2000), *Law & Economics* (3rd ed.), Addison-Wesley

Cooter, Robert D. (1996) "Decentralised Law for a Complex Economy: The Structural Approach to Adjudicating the New Law Merchant", 144 UNIVERSITY OF PENNSYLVANIA LAW REVIEW 1643

Cornish, William & David Llewellyn (2003), *Intellectual Property : Patents, Copyrights, Trade marks and Allied Rights*, London: Thomson Sweet & Maxwell, (5th ed.)

Correa, Carlos (2000), "In situ conservation and intellectual property rights", Stephen Brush (ed), *Genes in the Field: On-Farm Conservation of Crop Diversity*, Ottawa and Rome: IPGRI/IDRC/Lewis Publishers

Correa, Carlos (2000) *Options for the Implementation of Farmers' Rights at the national level*, Geneva: South Centre

Correa, Carlos (2000), "Protection of Traditional Systems of Medicine, Patenting and Promotion of Medicinal Plants", paper prepared for World Health Organization, Geneva

Correa, Carlos (2003) "Establishing a Disclosure of Origin Obligation in the TRIPS Agreement", Occasional Paper. No. 12, QUNO, Geneva

Cottier Thomas (1998), "The Protection of Genetic Resources and Traditional Knowledge: Towards More Specific Rights and Obligations in World Trade Law", 1 JOURNAL OF INTERNATIONAL ECONOMIC LAW 555-584

Cragg, G.M., J.E. Simon, J.G. Jato, and K.M. Snader (1996) "Drug discovery and development at the National Cancer Institute: Potential for new pharmaceutical crops", in J. Janick (ed.), *Progress in New Crops*, Arlington, VA : ASHS Press, pp. 554-560

Cragg, Gordon M. and David J. Newman (2001), "Natural Product Drug Discovery in the Next Millennium", *Pharmaceutical Biology* Vol. 39, Supplement, pp. 8-17

Crucible Group, (1994), *People, Plants, and Patents*, International Development Research Centre, Ottawa, Canada.

Crucible II Group (2000), *Seeding Solutions. Policy Options for Genetic Resources: People, Plants and Patents Revisited*, vol. 1, Rome: IDRC-IPGRI

Crucible II Group (2001), *Seeding Solutions: Options for National Laws Governing Access to and Control over Genetic Resources*, vol. 2, Rome: IDRC-IPGRI

- Dalton Rex (2002), "Tribes Query Motives of Knowledge Databases", 419 NATURE 866
- Cullet, Philippe & Radhika Kolluru (2003), 'Plant Variety Protection and Farmers' Rights - Towards a Broader Understanding', 24 DELHI LAW REVIEW 41
- Dalton, Rex (2004), "Bioprospects less than golden" 429 NATURE 59
- Dasgupta, Partha & Paul A. David (1994), "Toward a New Economics of Science", 23 RESEARCH POLICY 487, p. 496
- David, Paul A. (1993), "Knowledge, Property and the System Dynamics of Technological Change" in L. Summes and S. Shah (eds.) *Proceedings of the World Bank Annual Conference on Development Economics: 1992*, Washington D.C., World Bank Press
- David, Paul A., (2001), "Tragedy of the Public Knowledge 'Commons'? Global Science, Intellectual Property and the Digital Technology Boomerang," Research Memoranda 003, Maastricht: MERIT, Maastricht Economic Research Institute on Innovation and Technology
- David, Paul A. & Dominique Foray (1995), "Accessing and expanding the science and technology knowledge base", 16 SCIENCE, TECHNOLOGY INDUSTRY REVIEW 13–68
- David S. Tilford (1998), "Saving the Blueprints: The International Legal Regime for Plant Resources", 30 CASE WESTERN RESERVE JOURNAL OF INTERNATIONAL LAW 373
- Davison, Mark J. (2003), *The Legal Protection of Database*, Cambridge: Cambridge University Press
- De Juan Veronica (2002), "Comparative Study of Technology Transfer Practices in Europe and the United States", 14 JOURNAL OF THE ASSOCIATION OF UNIVERSITY TECHNOLOGY MANAGERS 31-58
- Dedeurwaerdere, Tom (2003), "Bioprospection: From the Economics of Contracts to Reflexive Governance" in Fondazione Eni Enrico Mattei, Working paper n° 56.04, 2003, Series: NRM -Natural Resources Management.
- Dedeurwaerdere, Tom (2003), "Bioprospection, gouvernance de la biodiversité et mondialisation", in LES CARNETS DU CENTRE DE PHILOSOPHIE DU DROIT, n°104
- Dedeurwaerdere, Tom (2004), "Biodiversity and Intellectual Property Law: The Stake of a Theory of Reflexive Governance", Second international workshop: "Governance of Biodiversity as a Global Public Good: Bioprospection, Intellectual property Rights and Traditional Knowledge", Louvain-la-Neuve, 5th and 6th February 2004
- Dedeurwaerdere, Tom (2004), "Bioprospecting, intellectual property law and evolutionary economics: the stake of a theory of reflexive governance", in M. Watanabe et al. (eds.), *Innovative Roles of Biological Resources Centres*, Tsukuba: World Federation for Culture Collections, pp. 389-395.
- Dedeurwaerdere, Tom (2005) "From Bioprospecting to Reflexive Governance", 53 ECOLOGICAL ECONOMICS 473
- Dedeurwaerdere, Tom. (2006), "The Institutional Economics of Sharing Biological Information", presented at "Building the European Commons: From Open Fields to Open Source," European Regional Meeting of the International Association for the Study of Common Property (IASCP), Brescia, Italy, March 23-25

Dedeurwaerdere Tom, Sélim Louafi, and Carmen Richerzhagen & Brendan Tobin (2005): *Roundtable on Practicality, Feasibility and Cost of Certificates of Origin*, Workshop Summary, 2nd Paris Roundtable on ABS Governance, 9-10 November 2004 (UNU/IAS-IDDRI-CPDR)

Dedeurwaerdere, Tom, Vijesh Krishna, Unai Pascual (2005), "Biodiscovery and Intellectual Property Rights: A Dynamic Approach to Economic Efficiency", in A. Kontoleon and U. Pascual (eds), *A Handbook of Biodiversity Economics*, Cambridge: Cambridge University Press

Deleuze, Jean Marie (1988), *Le Contrat international de licence de Know-how, savoir faire*, Paris, Milan, Barcelone, Mexico : Masson

Delmas, Maïté & Romaric Pierrel (2005) "Jardins botaniques et ressources génétiques: une histoire et un avenir commun", 5 LES ACTES DU BRG 593-613

Demaine, Linda J. & Aaron Xavier Fellmeth (2002), "Reinventing the Double Helix: A Novel and Nonobvious Reconceptualization of the Biotechnology Patent", 55 STANFORD LAW REVIEW 303

Demsetz, Harold (1967) "Towards a Theory of Property Rights" 57 AMERICAN ECONOMIC REVIEW 347

Demsetz Harold, "Property Rights", *New Palgrave Dictionary of Economics and the Law*, Peter Newman

Dennis, Philip A. (1988), "Herbal Medicines among the Miskito of Eastern Nicaragua", 42 ECONOMIC BOTANY 16-28

Dietz, Thomas, Elinor Ostrom and Paul C. Sterns (2003), "The Struggle to govern the Commons", 302 SCIENCE 1907-1912

Donnenwirth Jean, John Grace and Stephen Smith (2004) "Intellectual Property Rights, Patents, Plant Variety Protection and Contracts: A Perspective from the Private Sector", 9 IP STRATEGY TODAY 19-34

Downes, David (1997), *Using Intellectual Property as a Tool to Protect Traditional Knowledge: Recommendations for Next Steps*, Center for International Environmental Law, Washington, DC

Downes, David and Sarah Lair (1999), "Innovative Mechanism for Sharing Benefits of Biodiversity and Related Knowledge, case studies on geographical indications and trademarks", UNCTAD, Biotrade Initiative

Downes David R. (2000), "How intellectual property could be a tool to protect traditional knowledge", 25 COLUMBIA JOURNAL OF ENVIRONMENTAL LAW 253

Downes David R. and Sarah A. Laird (1999), *Community Registries of Biodiversity-Related Knowledge the Role of Intellectual Property in Managing Access and Benefit*, UNCTAD Biotrade Initiative

Drahos, Peter (1996), *A Philosophy of Intellectual Property*, Burlington: Ashgate

Drahos, Peter (1997), "Indigenous knowledge and the duties of intellectual property owners", INTELLECTUAL PROPERTY JOURNAL 11

Drahos, Peter (2000), "Indigenous Knowledge, Intellectual Property and Biopiracy: is a Global Bio-Collecting Society the Answer?", 22 EUROPEAN INTELLECTUAL PROPERTY REVIEW 245-250

Drahos, Peter (2004), "Towards an International Framework for the Protection of Traditional Group Knowledge and Practice", UNCTAD-Commonwealth Secretariat Workshop on Elements of National *sui Generis* Systems for the Preservation, Protection and Promotion of Traditional Knowledge, Innovations and Practices and Options for an international Framework, Geneva, 4-6 February

Dutfield, Graham (1999), "Protecting and Revitalising Traditional Ecological Knowledge: Intellectual Property Rights and Community knowledge databases in India", 6 PERSPECTIVES ON INTELLECTUAL PROPERTY 103

Dutfield, Graham (1999), "Rights, Resources and Responses" in Cultural and Spiritual Values of Biodiversity, UNEP

Dutfield, Graham (2000), *Intellectual Property Rights, Trade and Biodiversity*, London: Earthscan

Dutfield, Graham (2000) "The Public and Private Domains, Intellectual Property Rights in Traditional Knowledge", 21 SCIENCE COMMUNICATION 274-295

Dutfield, Graham (2001) "Trade-related aspects of traditional knowledge" 33 CASE WESTERN RESERVE JOURNAL OF INTERNATIONAL LAW 233-275

Dutfield, Graham (2002) "Indigenous peoples' declarations and statements on equitable research relationships", in S.A. Laird (Ed.), *Biodiversity and Traditional Knowledge: equitable partnerships in practice*, Sterling VA: Earthscan

Dutfield, Graham (2002) "Protecting Traditional Knowledge and Folklore", in F.W. Grosheide and J.J. Brinkhof (Eds.), *Intellectual Property Law: Articles on Cultural Expressions and Indigenous Knowledge*, Antwerp, Oxford and New York: Intersentia

Dutfield, Graham (2002) "Sharing the benefits of biodiversity: is there a role for the patent system?" 5 JOURNAL OF WORLD INTELLECTUAL PROPERTY 899-931

Dutfield, Graham (2003) *Intellectual Property Rights and the Life Science Industries: A Twentieth Century History*, Aldershot: Ashgate

Dutfield, Graham (2003) "Protecting Traditional Knowledge and Folklore: a Review of Progress in Diplomacy and Policy Formulation", Geneva: UNCTAD-ICTSD

Dutfield, Graham (2004), "Developing and Implementing National Systems for Protecting Traditional Knowledge: Experiences in Selected Developing Countries", in S. Twarog and P. Kapoor (Eds.), *Protecting and Promoting Traditional Knowledge: Systems, National Experiences and International Dimensions*, New York: United Nations, pp. 141-153

Dutfield, Graham (2004) *Intellectual Property, Biogenetic Resources and Traditional Knowledge*, London: Earthscan

Dutfield, Graham (2005), "Indigenous Peoples and Traditional Resource Rights", in S. Krimsky and P. Shorett (eds.), *Rights and Liberties in the Biotech Age: Why We Need a Genetic Bill of Rights*, Lanham, MD: Rowan & Littlefield

Dutfield, Graham (2005), "Legal and Economic Aspects of Traditional Knowledge", in J. Reichman and K.E. Maskus (Eds.), *International Public Goods and Transfer of Technology under a Globalized Intellectual Property Regime*, Cambridge: Cambridge University Press, pp. 495-520

Dutfield, Graham (2006) "Protecting Traditional Knowledge: Pathways to the Future", Geneva: International Centre for Trade and Sustainable Development (ICTSD)

- Duvick, D. (1989), "Variability in U.S. Maize Yields", in J. Anderson and P. Hazell (eds.) *Variability in Grain Yields*, Washington D.C: World Bank
- Eggert (1969), "Uses, New Uses and Chemical Patents--A Proposal", 51 JOURNAL OF PATENT AND TRADEMARK OFFICE SOCIETY 768
- Eggertsson, Thrainn (1990) *Economic Behavior and Institutions*, Cambridge: Cambridge University Press
- Eisenberg, Rebecca S. (1987), "Proprietary Rights and the Norms of Science in Biotechnology Research", 97 THE YALE LAW JOURNAL 185
- Eisenberg, Rebecca S. (1996) "Public Research and Private Development: Patents and Technology Transfer in Government Sponsored-Research", 82 Virginia Law Review 1694
- Eisenberg, Rebecca S. (2000), "Analyze this: a Law & Economics Agenda for the Patent System", 53 VANDERBILT LAW REVIEW 2082
- Eisenberg, Rebecca S. (2001), "Bargaining Over the Transfer of Proprietary Research Tools : Is This a Market Failing or Emerging ?", in Rochelle Dreyfus et al (eds.), *Expanding the Boundaries of Intellectual Property: Innovation Policy for the Knowledge Society*, New York: Oxford University Press
- Ekpere, J. A. (2000) "The OAU's Model Law", Organisation of African Unity; Scientific, Technical & Research Commission, Lagos
- Elisabethsky, Elaine (1991), "Folklore, Tradition or Know-How?", Cultural Survival Quarterly, summer, pp.9-13
- Ellickson Robert C. (1991) *Order without Law: How Neighbors Settle Dispute*, Cambridge: Harvard University Press
- Ellickson Robert. C. (1993), "Property in Land", 102 THE YALE LAW JOURNAL 1315
- Ellickson, Robert C., Carol M. Rose, and Bruce A. Ackerman (eds.) (2002) *Perspectives on Property Law*, (3rd ed.), New York & Gaithersburg: Aspen Law & Business
- Epstein, Richard A. (1994), "On the Optimal Mix of Private and Common Property", 11 SOCIAL PHILOSOPHY & POLICY 17
- Epstein, Richard A (2003), "Steady the Course: Property Rights in Genetic Material", John M. Olin Law & Economics Working Paper n° 152 (2nd series)
- Expert Group Report (2004), Management of Intellectual Property in Publicly-Funded Research Organisations: Towards European Guidelines, Brussels: European Commission
- FAO (1998), *Agricultural Land Use*, Rome: FAO
- FAO Commission on Plant Genetic Resources (1989), Implications of New Biotechnologies for the International Undertaking, CPGR/89/9
- Farnsworth, N. R. (1988), "Screening Plants for New Medicines" in E. O. Wilson, (ed.) *Biodiversity*, Washington, DC: National Academy Press, pp. 83-97
- Farrar, Curtis (2000), "The Consultative Group for International Agricultural Research", Case Study for the UN Vision Project on Global Public Policy Networks, available at <http://www.globalpublicpolicy.net>

Feit Ute, Marliese von den Diesh and Wolfram Lobin (eds.) (2005) Access and Benefit Sharing of Genetic Resources: Ways and Means for Facilitating Biodiversity Research and Conservation while safeguarding ABS Provisions, (German) Federal Agency for Nature Conservancy

Feyt, Henri (2001), "La protection de la propriété intellectuelle des obtentions végétales: Genèse et rapide historique de la mise en place des droits ", Colloque les brevets dans l'histoire: Propriété industrielle, historique et économique, Paris Sorbonne 1-2 October

Fienup-Riordan, Anna (1990) "Original Ecologists? The Relationship Between Yup'ik Eskimos and Animals" in A. Fienup-Riordan (ed.) *Eskimo Essays*, London: Rutgers UP

Fisher, William III (2001) "Theories of intellectual property", in Stephen Munzer (ed.), *New Essays in the Legal and Political Theory of Property*, Cambridge Studies in Philosophy and Law

Flores Palacios, Ximena (1998) "Contribution to the Estimation of Countries' Interdependence in the Era of Plant Genetic Resource", BACKGROUND STUDY PAPER 7 rev.1, FAO available at <ftp://ext-ftp.fao.org/ag/cgrfa/BSP/bsp7E.pdf>

Flury-Jeker, Anne-Marie(1987), *La protection juridique des obtentions végétales*, Neuchâtel, Switzerland: Editions Ides et Calendes

Foray, Dominique (2000), *L'économie de la connaissance*, Paris : La Découverte

Four Directions Council (1996), Forests, indigenous peoples and biodiversity. Contribution of the Four Directions Council to the Secretariat of the Convention on Biological Diversity, Lethbridge: FDC

Fowler, Cary (2000), "The Plant Patent Act of 1930: A Sociological History of its Creation", 82 JOURNAL OF PATENT AND TRADEMARK OFFICES SOCIETY 621

Fowler, Gary and Pat Mooney (1990) *Shattering. Food, Politics and the Loss of Genetic Diversity*, University of Arizona Press, Tucson

Franzosi, Mario (1997), "Patentable Inventions: Technical & Social Phases: industrial character and Utility", 19 EUROPEAN INTELLECTUAL PROPERTY REVIEW 251-254

Gadgil, Madhav (2000), "People's Biodiversity Registers: Lessons learnt" 2 ENVIRONMENT, DEVELOPMENT AND SUSTAINABILITY 323

Gadgil, Madhav (2004) "Report of the Workshop on Networking of Biodiversity Databases held at the Centre for Ecological Sciences", during March 23rd to 24th available at <http://wgbis.ces.iisc.ernet.in/biodiversity/Network/network.htm>

Gadgil, Madhav *et al.* (2000), "New Meanings for Old Knowledge: The People's Biodiversity Registers Program", 10 ECOLOGICAL APPLICATION 1307

Gadgil, Madhav *et al.* (2005), *People's Biodiversity Register: A Methodology Manual*. Indian Institute of Science - Centre for Ecological Sciences / Agharkar Research Institute, Bangalore, Karnataka, India / Pune, Maharashtra, India, available at www.ces.iisc.ernet.in/hpg/cesmg/pbrmanualnew.pdf

Gari, Josep A. (1997) "The Role of Democracy in the Biodiversity Issue: The Case of Quinoa", Center for Latin America Research and Documentation Papers, Amsterdam

Garí, Josep A. (2000), "Biodiversity conservation and use: Local and global considerations", SCIENCE, TECHNOLOGY AND DEVELOPMENT PAPERS, no 7, Center for International Development, Harvard University

- Garrison Wilkes, H. (1988), "Plant Genetic Resources over Ten Thousand Years: From a handful of Seed to the Crop-Specific Mega-Gene Banks", in Jack R. Kloppenburg Jr. (ed.) *Seeds and Sovereignty: The Use and Control of Plant Genetic Resources*, Durham: Duke University Press
- Gehl Sampath, Padmashree (2004), "Defining an Intellectual Property Right on Traditional Medical Knowledge: A Process-oriented Perspective", 7 JOURNAL OF WORLD INTELLECTUAL PROPERTY 711
- Gehl Sampath, Padmashree (2005), *Regulating Bioprospecting: Institutions for Drug Research, Access and Benefit Sharing*, Tokyo: United Nations University Press
- Ghosh, Shubha (2003) "Globalization, patents, and traditional knowledge", 17 COLUMBIA JOURNAL OF ASIAN LAW 73
- Ghosh, Shubha (2003) "Reflections on the Traditional Knowledge Debate", 11 CARDOZO JOURNAL OF INTERNATIONAL AND COMPARATIVE LAW 497
- Ghosh, Shubha (2003) "The Traditional Terms of the Traditional Knowledge Debate", 23 NORTHWESTERN JOURNAL OF INTERNATIONAL LAW AND BUSINESS 589
- Ghosh, Shubha (2003), "Traditional Knowledge, Patents and the New Mercantilism: Part One" 85 JOURNAL OF PATENT AND TRADEMARK OFFICES SOCIETY 828
- Ghosh, Shubha (2003), "Traditional Knowledge, Patents and the New Mercantilism: Part Two", 85 Journal of Patent and Trademark Offices Society 885
- Gilbert, Richard and Karl Shapiro, (1990) "Optimum Patent Length and Breadth" 21 RAND JOURNAL OF ECONOMICS 106
- Girsberger, Martin (1999), *Biodiversity and the Concept of Farmers' Rights in International Law. Factual Background and Legal Analysis*, Berne: Peter Lang
- Gollin Michael A.(1993), "An Intellectual Property Rights Framework for Biodiversity Prospecting», in Reid Walter V. *et al.*, *Biodiversity Prospecting*, Washington: World Resources Institute Books p. 172
- Golvan, Colin (1998), "Aboriginal art and the public domain" 9 JOURNAL OF LAW AND INFORMATION SCIENCE 122
- Gordon, Wendy J. (1994), "Assertive Modesty: an Economics of Intangibles" 94 COLUMBIA LAW REVIEW 2579
- Graff D. Gregory, Susan E. Collen, Kent J. Bradford, David Zilberman & Alan B. Bennet (2003), "The Public-private Structure of Intellectual Property Ownership in Agricultural Biotechnology", 21 NATURE BIOTECHNOLOGY 989
- Graff, G, A Bennett, B Wright and D Zilberman (2001), "Intellectual Property Clearinghouse Mechanisms for Agriculture: Summary of an Industry, Academia, and International Development Round Table", 3 IP STRATEGY TODAY 15-38
- Graff, G and D Zilberman (2001) "Towards an Intellectual Property Clearinghouse for Agricultural Biotechnology", 3 IP STRATEGY TODAY 1-13.
- Graff, Gregory D., Gordon C. Rausser, and Arthur A. Small (2003), "Agricultural Biotechnology's Complementary Intellectual Assets", 85 THE REVIEW OF ECONOMICS AND STATISTICS 349
- Green J.R. and Suzanne Scotchmer (1995), "On the Division of Profit in Sequential Innovation", 26 RAND JOURNAL OF ECONOMICS 20

- Griffiths, Thomas (1993) "Indigenous Knowledge and Intellectual Property: A preliminary Review of the Anthropological Literature, unpublished paper, quoted by Graham Dutfield (2000) "The Public and Private Domains, Intellectual Property Rights in Traditional Knowledge", 21SCIENCE COMMUNICATION 274-295
- Grifo, Francesca and David R. Downes (1996), "Agreement to Collect Biodiversity for Pharmaceutical Resource: Major Issues and Proposed Principles", in Brush, S. and D. Stibansky, (eds), *Valuing Local Knowledge*, Washington D.C. Island Press
- Grifo, Francesca and Joshua Rosenthal (eds.) (1997), *Biodiversity and Human Health*, Washington D.C.: Island Press
- Gupta, Anil K. (2001) "Framework for Rewarding Indigenous Knowledge in Developing Countries: Value Chain for Grassroots Innovations", Paper presented at WTO Expert Committee, 3 September
- Halewood, Mickael (1999) "Indigenous and Local Knowledge in International Law: A Preface to Sui Generis Intellectual Property Protection" 44 MCGILL LAW JOURNAL 953
- Hansen, Stephen A. and Justin van Fleet (2005) *Traditional Knowledge and Intellectual Property : A handbook on Issues and Options for traditional Knowledge Holders in Protecting Intellectual Property and Maintaining Biological Diversity*, Washington DC: AAAS
- Hardin, Garret (1968), "The Tragedy of the Commons ", 162 SCIENCE 1243
- Hardin, Lowell S. (2001) "Des intérêts bien compris", 62 COURRIER DE LA PLANETE 37
- Hardison, Preston D. (2003) "Communication to Canadian Indigenous Information Network" 4 August
- Harnay Sophie. & Alain. Marciano (2003), *Richard Posner : l'analyse économique du droit*, Paris : Michalon
- Hazell, P. (1984), "Sources of Increased Variability in Indian and US Cereal Production" AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS 66
- Heisey, P.W, C.S. Srinivasan and C. Thirtle (2001), "Public Sector Plant Breeding in a Privatizing World" AGRICULTURAL INFORMATION BULLETIN, No. 772 Economic Research Service, US Department of Agriculture, Washington D.C
- Helfer, Laurence R. (2005) "Using Intellectual Property Rights to Preserve the Global Genetic Commons: The International Treaty on Plant Genetic Resources for Food and Agriculture" in Keith Maskus and Jerome H. Reichman (eds.) *International Public Goods and Transfer of Technology Under a Globalized Intellectual Property Regime*, Cambridge: Cambridge University Press
- Heller, Michael A. (1998), "The Tragedy of the Anticommons: Property in the Transition from Marx to Markets", 111 HARVARD LAW REVIEW 621
- Heller, Michael A. (1999), "The Boundaries of Private property", 108 THE YALE LAW JOURNAL 1174
- Heller, Michael A. & Rebecca S. Eisenberg (1998), "Can Patent Deter Innovation ? The Anticommons in Biological Research", 280 SCIENCE 698
- Hendricks, J. W. (1988), "Power and Knowledge: Discourse and Ideological Transformation among the Shuar", 15 AMERICAN ETHNOLOGIST 216

Hendrickx, F., V. Koester and C. Prip (1994), "Access to Genetic Resources: A Legal Analysis" in Vicente Sanchez and Calestous Juma (eds.) *Biodiplomacy, Genetic Resources and International Relations*, Nairobi: ACTS

Hendriks, Janet W. (1988), "Power and Knowledge: Discourse and Ideological Transformation among the Shuar", 15 *AMERICAN ETHNOLOGIST*, 216-138

Henry, Michel Trommetter & Laurence Tubiana (2003), "Innovations et droits de propriété intellectuelle: quels enjeux pour les biotechnologies?", Rapport du Conseil d'Analyse Economique, Paris, La Documentation française

Hermitte, Marie-Angèle (2004), "La construction du droit des ressources génétiques exclusivismes et échanges au fil du temps" in Marie Angèle Hermitte et Philippe Khan (eds.) *Les ressources génétiques végétales et le droit dans les rapports Nord-Sud*, Bruxelles : Bruylant

Hess, Charlotte & Elinor Ostrom (2003), "Artifacts, Facilities and Content: Information as a Common Pool Resource", 66 *LAW AND CONTEMPORARY PROBLEMS* 111

Hettinger, Edwin C. (1989), "Justifying Intellectual Property" in 18 *PHILOSOPHY AND PUBLIC AFFAIRS* 31-52

Holm-Müller, Karin, Carmen Richerzhagen, Sabine Täuber (2005) *Users of Genetic Resources in Germany: Awareness, Participation and Positions regarding the Convention on Biological Diversity*, Bonn: Bundesamt für Naturschutz (BfN) Federal Agency for Nature Conservation

Holmstedt, B. and Bruhn J.G., "Ethnopharmacology: a challenge", 8 *JOURNAL OF ETHNOPHARMACOLOGY* 251-256

Howells, Jeremy & Carole McKinley (1999), "Commercialisation des résultats de la recherche universitaire en Europe", Rapport final au groupe d'experts sur la commercialisation des résultats de la recherche universitaire du Conseil consultatif (Canadien) des sciences et de la technologie, available at : <http://acst-ccst.gc.ca/comm/rpaper>.

Hugenholtz, Bernt (1999), "Code as Code, Or the End of Intellectual Property as We Know It", 6 *MAASTRICHT JOURNAL OF EUROPEAN AND COMPARATIVE LAW* 308-318

Hugues, Justin (1988), "The Philosophy of Intellectual Property", 77 *GEORGETOWN LAW JOURNAL*, 287

International Council for Science (2002), Science, Traditional Knowledge and Sustainable Development, ICSU SERIES ON SCIENCE FOR SUSTAINABLE DEVELOPMENT, No. 4

Jacobs P. & van Overwalle, Geertrui (2001), "Gene Patents: An Alternative Approach", 23 *EUROPEAN INTELLECTUAL PROPERTY REVIEW* 505-506

Jaffe Adam B. (2000), "The U.S. patent system in transition: policy innovation and the innovation process", 29 *RESEARCH POLICY*, pp. 531-557

James E. (1972) "Organization of the United States National Storage Laboratory", in E.H. Roberts (ed), *Viability of Seeds*, London: Chapman & Hall

Janis, Mark D. & Jay P. Kesan (2002), "U.S. Plant Variety Protection: Sound and Fury...?", 39 *HOUSTON LAW REVIEW* 727

- Jordan, Bertrand (2004), *Le clonage, fantasmes et réalités*, Paris: Milan
- Jukofsky, Diane (1991), "Medicinal Plant Research Leads Scientists to Rain Forest", DRUG TOPICS, April 22,
- Juma, Calestous (1989), *The Gene Hunters. Biotechnology and the Scramble for Seeds*, Princeton: Princeton University Press
- Kadidal, Shayana (1997) "Subject-Matter Imperialism? Biodiversity, Foreign Prior Art and the Neem Patent Controversy", 37 IDEA 371
- Karjala, Dennis S. (1994), "Misappropriation as a Third Intellectual Property Paradigm", 94 COLUMBIA LAW REVIEW 2594
- Karjala Dennis S. Paterson Robert K., (2003), "Looking Beyond Intellectual Property in Resolving Protection of the Intangible Cultural Heritage of Indigenous People", 11 CARDOZO JOURNAL OF INTERNATIONAL AND COMPARATIVE LAW 633
- Khan, Philippe (1998), "Les patrimoines communs de l'humanité: quelques réflexions", in Michel Prieur et Claude Lambrechts, *Les Hommes et l'Environnement, quels droits pour le vingt-et-unième siècle ?*, Mankind and Environment, what rights for the twenty first century? Etudes en Hommages à Alexandre Kiss, Paris, Editions Frison-Roche
- Kirat Thierry. (1999), *Economie du droit*, Paris : La Découverte
- Kiss, Charles-Alexandre (1983), "La notion de Patrimoine Commun de l'Humanité", 175 RECUEIL DE COURS DE L'ACADEMIE DE DROIT INTERNATIONAL DE LA HAYE 99-256
- Kitch, Edmund (1966), "Graham v. John Deere Co.: New Standards for Patents" Supreme Court Review 293
- Kitch, Edmund W. (2000), "Elementary and Persistent Errors in the Economic Analysis of Intellectual Property", 53 VANDERBILT LAW REVIEW 1727
- Klemperer, Paul (1990), "How Broad Should the Scope of Patent Protection Be?", 21 RAND JOURNAL OF ECONOMICS 113
- Kloppenbug Jr. Jack (1991), "No Hunting ! Biodiversity, Indigenous Rights and scientific poaching", CULTURAL SURVIVAL QUARTERLY, Summer, p.15
- Kloppenbug jr., Jack R. and Daniel Lee Kleiman (1988), "Plant Genetic Resources: The Common Bowl", in Jack R. Kloppenbug Jr. (ed.) *Seeds and Sovereignty: The Use and Control of Plant Genetic Resources*, Durham: Duke University Press
- Kloppenbug jr., Jack R., & DL Kleinman (1987), "Plant Germplasm Controversies- Analyzing empirically the Distribution of the World Plant Genetic Resources", 37 BIOSCIENCE 190-8
- Kocken J. and G. van Roozendaal, (1997), "The Neem Tree Debate". 30 Biotechnology and Development Monitor 8
- Kongolo, Tshimangala (2002), "Biodiversity and African Countries", 24 EUROPEAN INTELLECTUAL PROPERTY REVIEW 579-584
- Koopman Jerzy (2004) "Reconciliation of interest in Genetic and knowledge Resources: hurry cautiously!", 53 JOURNAL OF ECOLOGICAL ECONOMICS 523-541
- Korah, Valentine (2006), *Intellectual Property Rights and the EC Competition Rules*, Oxford: Hart Publishing

- Krasilovsky, M. William and Sidney Shemel (2003) *This Busines of Music: The definitive guide to the music industry* (9th ed.), New York: Bilboards Books
- Kraus, Michael I, (1999) "Property rules versus Liability rules" in Boudewijn Bouckaert and Gerrit De Geest (eds.) *Encyclopedia of Law & Economics*, available at <http://encyclo.findlaw.com/>
- Kretschmer, Martin (2002), "The failure of Property Rules in Collective Administration: Rethinking Copyright Societies as Regulatory Instruments", 24 EUROPEAN INTELLECTUAL PROPERTY REVIEW 126-137
- Krishna Vijesh V., Unai Pascual "Optimal Compensation for Indigenous Knowledge Holders in Biodiversity Contracts: a Case Study from India", Working Paper, Department of Land Economy, University of Cambridge
- Krumenacher Thomas J. (2004), "Protection for Indigenous Peoples and Their Traditional Knowledge: Would a Registry System Reduce the Misappropriation of Traditional Knowledge?", 8 MARQUETTE INTELLECTUAL PROPERTY LAW REVIEW 143
- Kuruk, Paul (1999) "Protecting Folklore under Modern Intellectual Property Regimes: A Reappraisal of the Tensions between Individual and Communal Rights in Africa and the United States, 48 AMERICAN UNIVERSITY LAW REVIEW 769-849,
- La Viña, A.G.N., M.J.A. Caleda and M.L.L Baylon (eds.) (1997) *Regulating Access to Biological and Genetic Resources in the Philippines. A manual on the Implementation of the Executive Order No. 247*, Quezon City
- Labadie, R.P. et al. (1989) "An Ethnopharmacological Approach to the Search for Immunomodulators of Plant Origin", 55 PLANTA MEDICA 339
- Laird, Sarah A. (ed.) (2002), *Biodiversity and Traditional Knowledge, Equitable Partnerships in Practice*, London: Earthscan
- Lambert Richard (2003) *Review of Business-University Collaboration*, Final Report, available at www.lambertreview.org.uk
- Landes, William M. & Richard A. Posner (1987), "Trademark Law: an Economic Perspective", 30 JOURNAL OF LAW AND ECONOMICS 265-309
- Landes, William M. & Richard A. Posner (2003), *The Economic Structure of Intellectual Property Law*, Cambridge: The Belknap Press of Harvard University Press
- Langdon, E. Jean (1986), "Las clasificaciones del Yaje dentro del Grupo Siona: Ethnobotanica, Ethnoquimica", 46 AMERICA INDIGENA 101
- Lange David and Jerome H. Reichman, (1998), "Bargaining Around the Trips Agreement: The Case for Ongoing Public-Private Initiatives to Facilitate Worldwide Intellectual Property Transactions", 9 DUKE JOURNAL OF COMPARATIVE AND INTERNATIONAL LAW JOURNAL 11
- Le Bas, Christian (1999), "Matériaux pour une Economie de la propriété intellectuelle: problématiques, perspectives et problèmes", 52 ECONOMIE APPLIQUEE 7-49
- Le Besnarais, J . M. (1976), "L'Amérique latine et le droit de la mer " NOTES ET ETUDES DOCUMENTAIRES n°4316-4317, 27 Septembre, p. 90
- Le Buanec, Bernard (2004), "Protection of Plant-Related Innovations: Evolution and Current Discussion", IP STRATEGY TODAY No. 9-2004. pp. 1-18

- Leistner, Matthias (2004) "Traditional Knowledge" in Silke von Lewinski (ed.), *Indigenous Heritage and Intellectual Property. Genetic Resource, Traditional knowledge and Folklore*, London-The Hague: Kluwer Law International
- Lerner Josh & Jean Tirole (2002) "Efficient Patent Pools", Working Paper 9175, NATIONAL BUREAU OF ECONOMIC RESEARCH
- Leskien, Dan and Michael Flitner, (1997), "Intellectual Property Rights and Plant Genetic Resources: Options for a Sui Generis System", ISSUES IN GENETIC RESOURCES No. 6
- Lessig, Lawrence (1999), *Code and other Laws of Cyberspace*, New York: Basic Books
- Lessig, Lawrence (2001), *The Future of Ideas*, New York: Random House
- Lessig, Lawrence (2004) *Free Culture: How Big Media Uses Technology and the Law to Lock Down Creativity*, New York: Penguin Press
- Lévêque François (1996) "Externalities, Public Goods and the Requirement of a State's Intervention in pollution abatement", Conference "Economics and Law of Voluntary Approaches in Environmental Policy" Venice, November 18-19
- Lévêque François & Yann Menière (2003), *Economie de la propriété intellectuelle*, Paris: La Découverte
- Lewis, Tracy and J. H. Reichman (2004), "Using Liability Rules to Stimulate Local Innovation in Developing Countries: A Law and Economics Primer," in Keith E. Maskus and J. H. Reichman (eds), *International Public Goods and Transfer of Technology under a Globalized Intellectual Property Regime*, Cambridge: Cambridge University Press
- Libecap, Gary "Common Property", *New Palgrave Dictionary of Economics and the Law*, Peter Newman
- Liebig, Klaus *et al.* (2002) "Governing Biodiversity. Access to Genetic Resources and Approaches to Obtaining Benefits from their Use: The Case of the Philippines", Reports and Working Papers 5/2002, Bonn: German Development Institute
- Lieting and van den Berghe (1998). "Leads for Antivirals from Traditional Medicines" in Prendergast *et al.*(eds.), *Plant for Food and Medicine*, The Royal Botanical Gardens, Kew, pp.333-344
- Lindstrom, Lamont (1990) *Knowledge and Power in a South Pacific Society*, Washington: Smithsonian Institution Press
- Liu, Yinliang (2003), "IPR Protection for New Traditional Knowledge: with a case study of Traditional Chinese Medicine", 25 EUROPEAN INTELLECTUAL PROPERTY REVIEW 194-199
- Loren, Lydia Pallas (2003) "Untangling the Web of Music Copyrights", 53 CASE WESTERN LAW REVIEW 673
- Lucas-Schloetter, Agnes (2004), "Folklore" (Part III, Section 4) in Silke von Lewinski (ed.), *Indigenous Heritage and Intellectual Property -Genetic Resources, Traditional Knowledge and Folklore*, The Hague, London and New York: Kluwer Law International,
- Lunney, Glynn S., jr. (2001), "E-Obviousness" 7 MICHIGAN TECHNOLOGICAL LAW REVIEW 363
- Mackay, Ejan (1994), "Legal Hybrids: Beyond Property and Monopoly?" 94 COLUMBIA LAW REVIEW 2630

- Malissard, Pierrick, Yves Gingras et Brigitte Gemme (2003), "La commercialisation de la recherche scientifique", 148 LES ACTES DE LA RECHERCHE EN SCIENCE SOCIALE 57-68
- Malpica Lizarzaburu C. (2004), "Implementing the Principles of the United Nations Convention on Biological Diversity: The Experience of Kina Biotech in Peru", IP STRATEGY TODAY No. 11-2004. pp. 21-26
- Mangolte, P.A. (1997), "La dynamique des connaissances tacites et articulées : une approche socio-cognitive", 50 ECONOMIE APPLIQUEE 105-134
- Maskus Keith E. and Jerome H. Reichman (2004), "The Globalization of Private Knowledge Goods and the Privatization of Global Public Goods", 7 JOURNAL OF INTERNATIONAL ECONOMIC LAW 279-320
- Maskus Keith E. and Jerome H. Reichman (eds.) (2005) *International public Goods and Transfer of Technology Under a Globalized Intellectual Property Regime*, Cambridge: Cambridge University Press
- Mathur E., C. Costanza, L. Christoffersen, C. Erickson, M. Sullivan, M. Bene and J.M. Short (2004), "An Overview of Bioprospecting and the Diversa Model", IP STRATEGY TODAY No. 11-2004. pp. 1-20.
- Maureen O'Rourke (2000), "Towards a Doctrine of Fair Use in Patent Law", 100 COLUMBIA LAW REVIEW 1177
- Maurer Stephen M. (2002), "Promoting and Disseminating Knowledge: The Public/private interface", paper prepared for the National Research Council", Symposium on the Role of Scientific and Technical data and Information in the Public Domain, available at www7.nationalacademies.org/biso/Maurer_background_paper.html
- May S. M. and L. Brooke (1997) "Inuit Science: Numavik's Experience in Canada" in IUCN Inter-Commission Task Force on Indigenous Peoples: *Indigenous Peoples and Sustainability: Case and Actions*, pp. 353-361
- Mc Gowan, David (2001) "The legal Implications of Open-Source Software", 2001 UNIVERSITY OF ILLINOIS LAW REVIEW 242
- McManis Chares R. (1999), "The Privatization or "Shrink-Wrapping" of American Copyright Law", 87 CALIFORNIA LAW REVIEW 173
- McManis Charles R. (2003), "Intellectual property, genetic resources and traditional knowledge protection: thinking globally, acting locally", 11 CARDOZO JOURNAL OF INTERNATIONAL AND COMPARATIVE LAW 547
- McShane, Thomas O. (2003), "The Devil in the Detail of Biodiversity Conservation", 17 CONSERVATION BIOLOGY 1
- Merges, Robert P. (1988), "Commercial Success and Patent Standards: Economic Perspectives on Innovation", 76 CALIFORNIA LAW REVIEW 805
- Merges, Robert P. (1994), "Of Property Rules, Coase, and Intellectual Property", 94 COLUMBIA LAW REVIEW 2655
- Merges, Robert P. (1996), "Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations", 84 CALIFORNIA LAW REVIEW 1293

- Merges, Robert P. (1996), "Property Rights Theory and The Commons : The Case of Scientific research", in Ellen Frankel Paul, Fred D. Miller, JR., and Jeffrey Paul(eds.) *Scientific Innovation, Philosophy, and Public policy*, Cambridge: Cambridge University Press
- Merges, Robert P. (1999), "As many as Six Impossible Patents before Breakfast: Property Rights for Business Concepts and Patent System Reform", 15 BERKELEY TECHNOLOGICAL LAW JOURNAL 577
- Merges, Robert P. (2000), "Intellectual Property Rights and the New Institutional Economics" 53 VANDERBILT LAW REVIEW 1857
- Merges, Robert P. (2001), "Institutions for Intellectual Property Transactions: The Case of Patent Pools" in Rochelle Dreyfus et al (eds.), *Expanding the Boundaries of Intellectual Property : Innovation Policy for the Knowledge Society*, New York: Oxford University Press
- Merges, Robert P. (2004) "From Medieval Guilds to Open Software: Informal norms, Appropriability Institutions, and Innovation", Conference on the Legal History of Intellectual Property, University of Wisconsin Law School, November 13
- Merges Robert P. (2004) "A new Dynamism in the Public Domain", 71 UNIVERSITY OF CHICAGO LAW REVIEW, 183-203,
- Merges, Robert P. and John F. Duffy (2002), *Patent Law and Policy: Cases and Materials*, Lexis Nexis, (3rd ed.)
- Merges, Robert P., Peter S. Mendel and Mark A. Lemley (2000), *Intellectual Property in the Technological Age* (2nd ed.), pp. 2-12
- Merges, Robert P. & Richard R. Nelson (1990), "On the Complex Economics of Patent Scope ", 90 COLUMBIA LAW REVIEW 83
- Meyer (1967), "Utility Requirement in the Statute", 49 JOURNAL OF THE PATENT OFFICES SOCIETY 533
- Meyers, Norman (1988) "Draining the Gene Pool: The Cause, Course and Consequences of Genetic Erosion", in Jack. R Kloppenburg jr. (ed.), *Seeds and Sovereignty: The Use and Control of Plant Genetic Resources*, Durham: Duke University Press
- Mgbeogi, Ikechi (2001, "Patents and Traditional Knowledge of the Use of Plants: Is a Communal Patent Regime Part of the Solution to the Scourge of Biopiracy", 9 INDIANA JOURNAL GLOBAL LEGAL STUDIES 163
- Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: Biodiversity Synthesis*, Washington: World Resources Institute
- Miller, James S. (1992), "The Discovery of Medicines and Forest Conservation", in Robert P. Adams and Janice E. Adams (eds.), *Conservation of Plant Genes: DNA Banking and in vitro Biotechnology*, San Diego: Academic Press
- Mirabel (1987), " 'Practical Utility' is a Useless Concept", 36 AMERICAN UNIVERSITY LAW REVIEW 811
- Modesto Heloísa S., Niessen S. (2005), "The Revival of Traditional Practices as a Response to Outsiders' Demands: The resurgence of natural dye use in San Juan La Laguna, Guatemala", 3 ETHNOBOTANY RESEARCH & APPLICATIONS 155-166
- Mooney, Pat Roy (1998), "The Parts of Life. Agricultural Biodiversity, Indigenous Knowledge, and the Role of the Third System", DEVELOPMENT DIALOGUE, Special Issue

- Moore, Gerald & Witold Tymowski (2005), *Explanatory Guide to the International Treaty on Plant Genetic Resources for Food and Agriculture*, IUCN ENVIRONMENTAL POLICY AND LAW PAPER No. 57 (Gland, Switzerland and Cambridge, UK: IUCN). Available at: www.iucn.org/themes/law/pdfdocuments/EPLP57EN.pdf
- Morin, Frédéric (2003), "Les accords de Bioprospection répondent-ils aux objectifs de la Convention sur la Diversité Biologique", 34 REVUE DE DROIT DE L'UNIVERSITE DE SHERBROOKE 308-343
- Moritz, Thomas (2002), "Building the Biodiversity Commons", D-LIB MAGAZINE, Vol. 8 N°6
- Mowery D.C. *et al.* (2001), "The Growth of the Patenting and Licensing by U.S. Universities: an assessment of the Effects of the Bayh-Dole Act of 1980", 99 RESEARCH POLICY 104
- Mueller, Janice M. (2001), "No Dilettante Affair: Rethinking the Experimental Use Exemption to patent Infringement for Biomedical Research Tools", 76 WASHINGTON LAW REVIEW 1
- Mustar, Philippe & Philippe Larédo (2002), "Innovation and Research Policy in France (1980-2000) or the Disappearance of the Colbertist State", 31 RESEARCH POLICY 55
- Nelson, Richard R. (1959), "The Simple Economics of Basic Scientific Research", 67 JOURNAL OF POLITICAL ECONOMY 323-348
- Nelson, Richard R (1994), "Intellectual Property Protection for Cumulative Systems Technology", 94 COLUMBIA LAW REVIEW, 2674
- Nelson, Richard R. & P. Romer (1994), "Science, Economic Growth, and Public Policy", in B.L. Smith & C.E. Barfield, *Technology, R&D, and the Economy*, Washington D.C.: The Brookings Institution Press, pp. 49-74
- Nettle D. and S. Romaine (2000), *Vanishing Voices: the Extinction of the World's Languages*, Oxford : Oxford Press
- Nguyen-Quaoc Dinh-Daillet-Pellet (1980), *Droit International Public*, 2e éd. Paris
- Noiville, Christine (1997), *Ressources génétiques et droit : Essai sur les régimes juridiques des ressources génétiques marines*, Paris : Institut Economique de la Mer, Pédone
- North, Douglas C. (1991) *Institutions, Institutional Change and Economic Performance*, Cambridge: Cambridge University Press
- Nozick Robert (1974), *Anarchy, State and Utopia*, New York: Basic Books
- Oddi, Samuel A. (1989), "Beyond Obviousness: Invention Protection for the Twenty-First Century", 38 AMERICAN UNIVERSITY LAW REVIEW 1097
- OECD (1999) *Handbook of Incentive Measures for Biodiversity: Design and Implementation*, Paris: OECD
- OECD (2000), *A New Economy? The Changing Role of Innovation and Information Technology in Growth*, available at <http://www.oecd.org/dsti/sti/index.htm>
- OECD (2001) *Biological Resource Centres: Underpinning the Future of Life Sciences and Biotechnology*, Paris: OECD
- OECD (2001), *Economic Issues in Access and Benefit Sharing of Genetic Resources: A Framework of analysis*, ENV/EPOC/GSP/BIO(2001)/FINAL, Paris: OECD

- OECD (2002), *Handbook of Biodiversity Valuation: A Guide for Policy Makers*, Paris: OECD
- OECD (1996), *Issues in the Sharing of Benefits Arising out of the Utilization of Genetic Resources*, OCDE/GD(97) Paris: OECD
- OECD, 2003. *Harnessing Markets for Biodiversity, Towards Conservation and Sustainable Use*, Paris: OECD
- Oguamanam, Chiki (2004), "Localizing Intellectual Property Right in the Globalization Epoch: Integrating Traditional Knowledge", 11 INDIANA JOURNAL GLOBAL LEGAL STUDIES 135
- Ogus, Anthony (1999) "Self-regulation", in Boudewijn Bouckaert and Gerrit De Geest (eds.) *Encyclopedia of Law & Economics*, available at <http://encyclo.findlaw.com/>
- Okediji, Ruth L. (2002), "Making Room at the Table: The Protection of Indigenous Knowledge at the Interstices of International Law, Human Rights and Intellectual Property", in CILP, Lecture Series Pub., University of Toronto.
- Oliver Williamson (1985), *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, New York: The Free Press.
- Onwuekwe Chika, (2004) "The Commons Concept and Intellectual Property Right Regime: Whither Plant Genetic Resources and Traditional Knowledge?", 2 PIERCE LAW REVIEW 66
- Ostrom (1999) "Private and Common Property" in Boudewijn Bouckaert and Gerrit De Geest (eds.) *Encyclopedia of Law and Economics* <http://encyclo.findlaw.com/>
- Ostrom, Elinor (1990), *Governing the Commons: the Evolution of Institutions for Collective Action*, Cambridge: Cambridge University Press
- Ostrom, Elinor (2002), "Property Rights Regimes and Common Goods: A Complex Link" in: Adrienne Heritier (ed.) *Common Goods: reinventing European and International Governance*, Rowman & Littlefield Publishers
- Pan, Peter G. (2006), *Bioprospecting: Issues and Policy Considerations*. Honolulu, HI: Legislative Reference Bureau
- Parisi, Francesco (1999), "Spontaneous Emergence of Law: Customary Law", in Boudewijn Bouckaert and Gerrit De Geest (eds.) *Encyclopedia of Law & Economics*, <http://encyclo.findlaw.com/>
- Perrault, Anne (2004), "Facilitating Prior Informed Consent in the Context of Genetic Resources and Traditional Knowledge" 4 SUSTAINABLE DEVELOPMENT LAW & POLICY 21
- Pires de Carvalho, Nuno (2000), "Requiring Disclosure of Origin of Genetic Resources, and Prior Informed Consent in Patent applications without infringing the TRIPS Agreement: The Problem and the Solution", WASHINGTON UNIVERSITY JOURNAL OF LAW AND POLICY 371
- Pistorius Robin (1997), *Scientists, Plants and Politics: A History of the Plant Genetic Resources Movement*, Roma: IPGRI
- Polski Margaret (2004), "The Institutional Economics of biodiversity, Biological Materials and bioprospecting", Second international workshop: "Governance of Biodiversity as a Global Public Good: Bioprospection, Intellectual property Rights and Traditional Knowledge", Louvain-la-Neuve, 5th and 6th February 2004

Posey Darrel A. (1985), "Indigenous management of tropical forest ecosystems: the case of the Kayapo Indians of the Brazilian Amazon", 3 AGROFORESTRY SYSTEMS 139-158

Posey, Darrel (1990), "The Science of the Mebengokre." ORION NATURE QUARTERLY (Summer): 16-24

Posey Darrel A. and Graham Dutfield (1996), *Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local Communities*, Ottawa: International Development Research Centre

Posey, Darrel & Graham Dutfield (1998) "Plants, Patent and Traditional Knowledge : Ethical Concerns of Indigenous and Traditional Peoples, in Van Overwalle G. (ed), *Otrooierecht, ethiek en biotechnologie, - Patent Law, Ethics and Biotechnology - Droit des brevets, éthique et biotechnologie*, (CIR-Reeks 13), Bruxelles: Bruylant

Posner, Eric A. (2000), *Law and Social Norms*, Cambridge: Harvard University Press

Posner, Richard A. (2003), *Economic Analysis of Law* (6th ed.), New York: Aspen Publishers

Powell, Walter W. (2001), "Networks of Learning in Biotechnology: Opportunities and Constraints Associated with Relational Contracting in Knowledge-Intensive Field", in Rochelle Dreyfus, *et. al.*, *Expanding the Boundaries of Intellectual Property, Innovation Policy for the Knowledge Society*, New York: Oxford University Press

Principe, Peter P. (1989) "The Economic Significance of Plants and Their Constituents as drug", in H. Wagner, H. Hikino and N.R. Farnsworth (eds.) *Economic And Medicinal Plant Research*, , London: Academic Press, Volume 3, pp. 1-17

R Lee, M.J. Balick, D.L. Ling, F. Sohl, B.J. Brosi, W. Raynor (2001), "Cultural dynamism and change-an Example from the Federated States of Micronesia" 55 ECONOMIC BOTANY 9-13

Rabobank (1994), *The World Seed Market: Developments and Strategy*, Agricultural Economic Institute (LEI-DLO)/Rabobank/Ministry of Agriculture, Nature Management and Fisheries, Netherlands

Ragavan, Srividhya (2001), "Protection of Traditional Knowledge", 2 MINNESOTA INTELLECTUAL PROPERTY REVIEW 1

Rai, Arti K. (1999) "Regulating Scientific research: Intellectual Property Rights and the Norms of Science", 94 NORTH WESTERN UNIVERSITY LAW REVIEW 77

Rai, Arti K. (2001), "Fostering Cumulative Innovation in the Biopharmaceutical Industry: The Role of Patent and Antitrust", 16 BERKELEY TECHNOLOGY LAW JOURNAL 813

Rai, Arti K. and Rebecca S. Eisenberg (2003), "Bayh-Dole Reform and the Progress of Biomedicine", 66 LAW AND CONTEMPORARY PROBLEMS 288

Rangenakar, Dwijen (2002), "Can TRIPs deter innovation? The Anticommons and the Local Public Goods in Agricultural research", Paper for the Conference Science and Citizenship in a Global Context: Challenges from New Technologies, Institute of Development studies, University of Sussex, Brighton, UK 12-13 December 2002

Raup, D. (1988) "Diversity Crises in the Geological Past", in E.O. Wilson (ed.) *Biodiversity*, Washington D.C: National Academy Press

- Reichman, Jerome H. (1994), "Legal Hybrids Between the Patent and Copyright Paradigms, 94 COLUMBIA LAW REVIEW, 2432
- Reichman, Jerome H. (1996), "From Free-Riders to Fair Followers: Global Competition Under the TRIPS Agreement", 29 NEW YORK UNIVERSITY JOURNAL INTERNATIONAL LAW & POLITICS 11-93
- Reichman, Jerome H. (1998), "Securing Compliance with the TRIPS Agreement After U.S. v. India", 4 JOURNAL OF INTERNATIONAL ECONOMIC LAW 585
- Reichman, Jerome H. (1999), "Privately Legislated Intellectual Property Rights: Reconciling Freedom of Contract with Public Good Uses of Information", 147 UNIVERSITY OF PENNSYLVANIA LAW REVIEW 875
- Reichman, Jerome H. (2000), "Of Green Tulips and legal Kudzu: Repacking Rights in Subpatentable Innovation", 53 VANDERBILT LAW REVIEW 1743
- Reichman, Jerome H. (2002), "A Compensatory Liability Regime for applications of traditional knowledge ", presented to the Cardozo Symposium on the Legal Protection of Traditional Knowledge, New York February 23-24
- Reichman, Jerome H. (2002) "Database Protection in a Global Economy" REVUE INTERNATIONALE DE DROIT ECONOMIQUE 455-504
- Reichman, Jerome H. (2003), "Saving the Patent Law from Itself: Informal Remarks Concerning the Systemic Problems Afflicting Developed Intellectual Property Regime" in F. Scott Kieff (ed.), *Perspectives on Properties of the Human Genome Project*, Elsevier Academic Press
- Reichman, Jérôme H. and Catherine Hasenzahl (2003) *Non-Voluntary Licensing of Patented Inventions: Historical Perspective, Legal Framework under TRIPS, and an Overview of the Practice in Canada and the United States of America*, UNCTAD/ICTSD Capacity Building Project on Intellectual Property Rights and Sustainable Development (Issue Paper No. 5)
- Reichman, Jerome H. and Paul F. Uhler (2003), "A Contractually Reconstructed Research Commons for Scientific Data in a Highly Protectionist Intellectual Property Environment", 66 LAW AND CONTEMPORARY PROBLEMS 315
- Reichman, Jerome H. & Pamela Samuelson (1997), "Intellectual Property Rights in Data?", 50 VANDERBILT LAW REVIEW 49
- Reichman, Jerome H. & Paul F. Uhler (1999) *Database Protection at the Crossroads: Recent Developments and Their Impact on Science and Technology*, 14 BERKELEY TECHNOLOGY LAW JOURNAL 793
- Remiche, Bernard (1997), "Le droit des brevets face à la mondialisation de l'économie", ANNALES DE DROIT DE LOUVAIN 181
- Remiche, Bernard (2000) "Le brevet pharmaceutique entre intérêts privés et publics : un équilibre impossible ?", REVUE INTERNATIONALE DE DROIT ECONOMIQUE 197
- Remiche, Bernard (2003), "Brevetabilité et innovation contemporaine: quelques réflexions sur les tendances actuelles du droit des brevets", in Vivant Michel (ed.), *Protéger les Innovations de Demain: Biotechnologies, Logiciels et méthodes d'affaires*, Institut National de la Propriété industrielle, La Documentation Française
- Révélant, Olivier (2001), *La médecine de demain, Le gène apprivoisé*, Paris: Milan

- Rich, Giles S. (1963), "Congressional Intent - Or, Who Wrote the Patent Act of 1952", First Annual Institute on Patent Law Southwestern Legal Foundation, March
- Richerzhagen, Carmen and K. Holm-Müller (2005), "The Effectiveness of Access and Benefit Sharing in Costa Rica: Implications for National and International Regimes", 53 *ECOLOGICAL ECONOMICS* 445
- Rifkin, Jeremy (1998), *The Biotech Century, Harnessing the Gene and Remaking the World*, New York: Jeremy P. Tarcher/Putnam
- Robbinson, Tara Rodden (2005), *Genetics for Dummies*, Indianapolis: Wiley Publishing
- Robinson, D.F. (2006) *Governance and Micropolitics of Traditional Knowledge, Biodiversity and Intellectual Property in Thailand*, Research Report, National Human Rights Commission of Thailand, UNSW and University of Sydney
- Rose, Carol (1986), "The Comedy of the Commons: Customs, Commerce and Inherently Public Property", 53 *UNIVERSITY OF CHICAGO LAW REVIEW* 711
- Rose Carol (1998), "Eldred v. Reno. The Several Futures of Property: Of cyberspace and Folk Tales, Emission Trades and Ecosystems" 83 *MINNESOTA LAW REVIEW* 129
- Rose, Carol (2003), "Romans, Roads, and Romantic Creators: Traditions of Public Property in the Information Age" 66 *LAW AND CONTEMPORARY PROBLEMS*, p. 89
- Rose, Carol M. (1997), "The Shadow of the Cathedral" 106 *THE YALE LAW JOURNAL* 2175
- Rose, Gregory (1996), "International Regimes for the Conservation and Control of Plant Genetic Resources" in Michael Bowman and Catherine Redgwell (eds), *International Law and the Conservation of Biological Diversity*, London: Kluwer Law International
- Rosemberg, Nathan (1976), *Perspective on Technology*, Cambridge: Cambridge University Press
- Roth-Arriaza, Naomi (1996), "Of Seeds and Shamans: The Appropriation of the Scientific and Technical Knowledge of Indigenous and Local Communities", 17 *MICHIGAN JOURNAL OF INTERNATIONAL LAW* 919
- Ruiz Müller, Manuel (2000), "Regulating Bioprospecting and Protecting Indigenous Peoples Knowledge in the Andean Community: Decision 391 and its Overall Impacts in the Region", paper for UNCTAD BIOTRADE Initiative, Expert Meeting on Traditional Knowledge, Geneva
- Ruiz Müller, Manuel (2002), *The International Debate on Traditional Knowledge as Prior Art in the Patent System: Issues and Options for Developing Countries*. Center for International Environmental Law (CIEL) / South Centre, Geneva, Switzerland (www.ciel.org)
- Ruiz Muller, Manuel. (2006) *La Protección Jurídica de los Conocimientos Tradicionales: Algunos Avances Políticos y Normativos en América Latina*, Lima - Perú: UICN, BMZ, SPDA, available at http://www.sur.iucn.org/publicaciones/lista_documentos.cfm
- Ruiz-Muller Manuel (2004), *An analysis of the implications of intellectual property rights (IPR) on the Global Biodiversity Information Facility (GBIF)* available at <http://www.gbif.org/prog/ocb/iprmtg>

Ruiz-Muller, Manuel (2006), "Farmers' Rights in Peru - A case study", Background Study 3, *The Farmers' Rights Project*, Fridtjof Nansen Institute Report 5/2006, Lysaker, FNI, available at <http://www.fni.no/doc&pdf/FNI-R0506.pdf>

Ruiz-Muller Manuel, Isabel Lapena, Susanna E Clark. (2004), "The Protection of Traditional Knowledge In Peru: A Comparative Perspective", 3 WASHINGTON UNIVERSITY GLOBAL STUDIES LAW REVIEW 755

Ruth L. Gana (1995), "Has Creativity Died in the Third World? Some Implications of the Internationalization of Intellectual Property", 24 DENVER JOURNAL OF INTERNATIONAL LAW AND POLICY 109

Safrin, Sabrina (2004), "Hyperownership in a Time of Biotechnological Promise: The International Conflict to Control the Building Blocks of Life" 98 THE AMERICAN JOURNAL OF INTERNATIONAL LAW 641

Salem, Mahmoud (1983), "La participation de la communauté internationale à la gestion des ressources phyto-génétiques", in Philippe Khan & Jean-Claude Fritz (eds) *La Gestion des Ressources Naturelles d'Origine Agricole*, Paris : Librairie technique

Samuel A. Oddi (1989), "Beyond Obviousness: Invention Protection for the Twenty-First Century", 38 AMERICAN UNIVERSITY LAW REVIEW 1097

Saviotti, Paul P. (1998), "Industrial Structure and the Dynamics of Knowledge Generation in Biotechnology" in Senker and van Vliet (eds.), *Biotechnology and Competitive Advantage: Europe Firms and the US Challenge*, Edward Elgar, pp. 19-44

Scalise, David G. & Daniel Nugent (1995), "International Intellectual Property Protections for Living Matter: Biotechnology, Multinational Conventions and the Exception for Agriculture", 27 CASE WESTERN RESERVE JOURNAL OF INTERNATIONAL LAW 83

Schulte-Tenckhoff, Isabelle (1997), *La question des peuples autochtones*, Bruxelles-Paris: Bruylant-L.G.D.J

Scotchmer Suzanne (1991), "Standing on the Shoulders of Giants: Cumulative Research and the Patent Law", 5 JOURNAL OF ECONOMIC PERSPECTIVE 29

Sedjo, Roger A. (1992), "Property Rights, Genetic Resources, and Biotechnological Change", 35 THE JOURNAL OF LAW AND ECONOMICS 199-213

Sell, Susan K. (1998), *Power and Ideas, North-South Politics of Intellectual Property and Antitrust*, New York: State University of New York

Shapiro, Carl (2001), "Navigating the Patent Thicket: Cross-Licenses, Patents Pools and Standards Setting" in Adam Jaffe, Joshua Lerner, and Scott Stern (eds.) *Innovation Policy and the Economy*, Volume I, MIT Press

Sherman, Brad (2003), "Regulating Access and Use of Genetic Resources: Intellectual Property Law and Biodiscovery", 25 EUROPEAN INTELLECTUAL PROPERTY REVIEW 301-308

Smale *et al.* (2002), "Dimensions of Diversity in Modern Spring Bread Wheat in Developing Countries from 1965" 42 CROP SCIENCE 6 (November-December)

Smith, Charles E. (1984) "Comment: Requirement for Patenting Chemical Intermediates: Do they accomplish the Statutory Goals?" 29 ST LOUIS UNIVERSITY LAW JOURNAL 191

- Solow, Robert (1974), "The Economics of Resources or the Resources of Economics", 64 AMERICAN ECONOMIC REVIEW, 1-12
- Stephen Ladas (1975), Patents, Trademarks, and Related Rights. National and International Protection, Cambridge: Cambridge University Press
- Stix, Gary (2006), "Owning the Stuff of Life" SCIENTIFIC AMERICAN, February p. 56
- Strauss, Joseph (1986), "Patent Protection for New Varieties of Plants: Should 'Double Patenting' Be Prohibited?" 17 INTERNATIONAL REVIEW OF INDUSTRIAL PROPERTY AND COPYRIGHT LAW 95
- Strauss, Joseph (1989), "AIPPI and the Protection of Inventions in Plants -Past Developments, Future Perspectives", 20 INTERNATIONAL REVIEW OF INDUSTRIAL PROPERTY AND COPYRIGHT LAW 600
- Strowel, Alain & Carine Doutrelepon (1989) "La Socialisation du Droit d'Auteur à travers la Généralisation des Licences non volontaires: un danger ou une nécessité?" 22 REVUE INTERDISCIPLINAIRE D'ETUDES JURIDIQUES 89 à 105
- Strowel Alain, & Estelle Derclaye (2001) *Droit d'auteur et numérique : logiciels, bases de données, multimédia : droit belge, européen et comparé*, Bruxelles: Bruylant
- Svarstad, Hanne and Schivcharn S. Dhillon (eds.) (2000), *Responding to Bioprospecting. From Biodiversity in the South to Medicines in the North*, Oslo: Spartacus Forlag
- Swanson T.M. & R.A. Luxmore (1997), *Industrial Reliance on Biodiversity*, World Conservation Press, WCMC? Cambridge, UK,
- Swanson, Timothy M. (1996), "The Reliance of Northern Economies of Southern Biodiversity: Biodiversity as Information", 17 ECOLOGICAL ECONOMICS 1-8
- Swanson, Timothy M. (1997), *Global Action for Biodiversity. An International Framework for Implementing the Convention on Biological Diversity*, London: Earthscan
- Swanson, Timothy M. (1998), "Property Rights Issues Involving Plant Genetic Resources: Implications of Ownership for Economic Efficiency", CSERGE Working Paper GEC 98-13
- Swanson, Timothy M. (1999), "Why is there a Biodiversity Convention? The International interest in centralized development planning", 75 INTERNATIONAL AFFAIRS 307-331
- Swanson, Timothy M. & Andreas Kontoleon (2003), "Conflicts in Wildlife Conservation: Aggregating Total Economic Values", Paper presented at the Fourth BIOECON Workshop on The Economics and Biodiversity Conservation, 28th-29th August, 2003, Venice, Italy
- Swanson, Timothy M. & Timo Goeshl (1998) "The Management of Genetic Resources for Agriculture: Ecology and Information, externalities and policies", CSERGE Working Paper GEC 98-12
- Swanson, Timothy M. & Timo Goeshl (1999), "Endogenous Growth and Biodiversity: the Social Value of Genetic Resources for R&D", CSERGE Working Paper GEC 99-11
- Swanson, Timothy & Timo Goeshl (2004), "Diffusion and Distribution: The Impacts on Poor Countries of Technological Enforcement within the Biotechnological Sector", Second international workshop: "Governance of biodiversity as a Global Public Good:

Bioprospection, Intellectual property Rights and traditional Knowledge", Louvain-la-Neuve, 5th and 6th February 2004

Swiderska K., Daño E., Dubois O. (2001) *Developing the Philippines' Executive Order No. 247 on Access to Genetic Resources*, London: International Institute for Environment and Development (IIED) and Earthprint Ltd

Swiderska, Kristina (2001), *Stakeholder Participation in Policy on Access to Genetic Resources, Traditional Knowledge and Benefit-Sharing. Case studies and Recommendations*, London: International Institute for Environment and Development (IIED) and Earthprint Ltd

Swiderska, Kristina, Elenita Daño and Olivier Dubois (2001), *Developing the Philippines Executive Order 247 on Access to Genetic Resources*, London: by International Institute for Environment and Development (IIED)

Taubman, Anthony (2001), "The way ahead: Developing international protection for geographical indications : thinking locally, acting globally", Symposium on the international protection of geographical indications, organized by WIPO and DNPI, Montevideo, November 28 and 29, Doc WIPO/GEO/MVD/01/09

Taubman, Antony (2004) "Saving the Village: Conserving Jurisprudential Diversity in the International Protection of Traditional Knowledge" in Keith E. Maskus and Jerome H. Reichman (eds.) (2005) *International public Goods and Transfer of Technology Under a Globalized Intellectual Property Regime*, Cambridge: Cambridge University Press

Ten Kate, Kerry and Adrian Wells, "The Access and Benefit Sharing Policies of the United States National Cancer Institute: A Comparative Account of the Discovery and Development of the Drugs Calanoides and Topotecan", Submission to the Executive Secretary of the Convention on Biological Diversity by the Kew Royal Botanic Garden, available on the website of the Secretariat at <http://www.biodiv.org/doc/case-studies/default.asp>

Ten Kate, Kerry and Sarah Laird (1999), *The Commercial Use of Biodiversity*, Earthscan: London

The Financial Express (2005) "SAARC to Set Up Traditional Knowledge Digital Library", New Delhi, 3 January

The Parliament of the Commonwealth of Australia (2001) *Bioprospecting: Discoveries Changing the Future: Inquiry into development of high technology industries in regional Australia based on bioprospecting*

Tilford, David (1998) "Saving the blueprints: The International Legal Regime for Plant Resources", 30 CASE WESTERN JOURNAL OF INTERNATIONAL LAW 373

Tirole, Jean (2003), "Protection de la propriété intellectuelle: une introduction et quelques pistes de réflexion", Rapport du Conseil d'Analyse Economique, Paris: La documentation française

Tobin B. and Swiderska K. (2001), *Speaking in Tongues: Indigenous Participation in the Development of a sui generis regime to Protect Traditional Knowledge in Peru*, London: International Institute for Environment and Development (IIED) and Earthprint Ltd

Tobin, Brendan (1997), "Certificates of Origin: A Role for IPR Regimes in Securing Prior Informed Consent " in John Mugabe, *et al.* (eds.) *Access to Genetic Resources: Strategies for Sharing Benefits*, Nairobi: ACTS Press.

Tobin, Brendan (1994), "Alternative mechanisms for Protection of Indigenous Rights", Symposium of Indigenous Peoples of Latin America: "Indigenous Peoples, Biodiversity and Intellectual Property." Santa Cruz, Bolivia, 27-30 September 1994

Tobin, Brendan (2001), "Redefining Perspectives in the Search for Protection of traditional Knowledge: A Case Study from Peru", 10 REVIEW OF EUROPEAN COMMUNITY & INTERNATIONAL ENVIRONMENTAL LAW 47-64

Tobin, Brendan (2004) "Towards an international Regime for Protection of Traditional Knowledge: Reflections on the Role of Intellectual Property Rights" paper presented at the International Conference on "Bioethical Issues of Intellectual Property in Biotechnology", Tokyo, Japan, 6-7 September available at www.shef.ac.uk/ipgenethics/conference/papers/Tobin.pdf

Tobin, Brendan, David Cunningham, and Kazuo Watanabe (2004), "The Feasibility, Practicality and Cost of a Certificate of Origin System for Genetic Resources. Preliminary Results of Comparative Analysis of Tracking Material in Biological Resources Centers and of Proposals for a Certification Scheme" Paper Submitted by the United Nations University to the Secretariat of the Convention on Biological Diversity for the Third Meeting of the Ad-Hoc Working Group on Access and Benefit Sharing Bangkok, 14-18 February UNEP/CBD/WG-ABS/3/INF/5

Trommetter, Michel (2000) "Gérer la conservation des ressources génétiques végétales : valeur et valorisation des collections", 9 CAHIERS AGRICULTURES 381-389.

Trommetter, Michel (2001) " La conservation des ressources phytogénétiques en réseau: incitations économiques et contraintes institutionnelles ", GENETICS SELECTION EVOLUTION, n°33, Supplément 1, pp. 537-556

Trommetter, Michel (2003), "Quels marchés pour les ressources génétiques ?", Grenoble: Document de travail GAEL

Trommetter Michel (2004), "Biodiversity and International Stakes: A question of Access?" 53 ECOLOGICAL ECONOMIC 573-583

Tsosie, Rebecca (1996), "Tribal environmental Policy in a Era of Self-Determination: The Role of Ethics, Economics and Traditional Knowledge", 21 VERMONT LAW REVIEW 225

Tulalip Tribes (2003) *Statement by the Tulalip Tribes of Washington on Folklore, Indigenous Knowledge, and the Public Domain*, July 09 at the Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore, Fifth session, Geneva, July 5-17

Tulalip Tribes of Washington (2003), *Statement on Folklore, Indigenous Knowledge, and the Public Domain* at the fifth session of the WIPO- IGC, July 09, in WIPO/GRTKF/IC/6/14

U.N. Subcommission on Prevention of Discrimination and Protection of Minorities (1983) Study of the Problem of Discrimination against Indigenous Populations. José Martinez Cobo, special rapporteur. U.N. Doc. E/C.N.4/Sub.2/1986/7 and Addenda 1-4

U.S. National Research Council (1993), *Managing Global Genetic resources*, Washington D.C: National Academy Press,

[U.S.] National Research Council (1972) *Genetic Vulnerability of Major Crops*, Washington D.C: National Academy of Science

Udehn, Lars (1993) "Twenty Five Years with the Logic of Collective Action" 36 ACTA SOCIOLOGICA 239

United Nations Committee on Human Rights, Report of the Working Group on Indigenous Populations on its eleventh session (E/CN.4/Sub.2/1993/29), annex I

US Report of the National Institute of Health (NIH) Working Group on Research Tools, presented to the Advisory Committee to the Director (June 4, 1998) available at <http://www.nih.gov/news/researchtools/index.htm>

Utkarsh, G. (2002) "Documentation of Traditional Knowledge: People's Biodiversity Registers (PBRs)", Foundation for Revitalization of Local Health Traditions (FRLHT), India. Available at: <http://www.ictsd.org/dlogue/2002-04-19/Utkarsh.pdf>

Van Caeneghem, William (2002), "The Public Domain Scientia Nullis?", 24 EUROPEAN INTELLECTUAL PROPERTY REVIEW 324-330

van der Kooij, Paul (2002), "Defending PBR: P, B, or (c) ?", 24 EUROPEAN INTELLECTUAL PROPERTY REVIEW 1

Van Overwalle, Geertrui (2001), "Legal Protection of Traditional Knowledge. A Synthesis", in F.W. Grosheide and Jan J. Brinkhof (eds.) *Cultural Identity and Indigenous Knowledge*, Utrecht:Interscientia

Van Overwalle, Geertrui (2001), "Traditional Medicinal Knowledge, Patents and the Convention on Biological Diversity", REVUE DE DROIT INTELLECTUEL - L'INGÉNIEUR CONSEIL 161-182

Van Overwalle, Geertrui (2002), "Belgium Goes its Own Way on Biodiversity and Patents", 24 EUROPEAN INTELLECTUAL PROPERTY REVIEW 233-236

Van Overwalle, Geertrui (2003), "Het Status van Academisch Kennis", 13 ETHISCHE PERSPECTIEVEN 8-39

Van Overwalle, Geertrui (2003) "Holder and User Perspectives in the Traditional Knowledge Debate" Conference on Biodiversity, Biotechnology and the Protection of Traditional Knowledge Washington University School of Law Saint Louis April 4-6, 2003

Van Overwalle, Geertrui (1996), *Octrooieerbaarheid van Plantenbiotechnologische Uitvindingen. Patentability of Plant Biotechnological Inventions*, Brussels: Bruylant

Van Overwalle, Geertrui (1999), "Patent Protection for Plants: A comparison of American and European Approaches", 39 JOURNAL OF LAW AND TECHNOLOGY 143

Velvel (1967), "A Critique of *Brenner v. Manson*", 49 JOURNAL OF PATENT OFFICES SOCIETY 5

Visser, Bert, Derek Eaton, Niels Louwaers and Jan Engels (2000), "Transaction Costs of Germplasm Exchange of Bilateral Agreements", Global Forum on Agricultural Research, May 21-23, Dresden Germany

Visser, Bert *et al.* (2000), "Transaction Costs of Germplasm Exchange Under Bilateral Agreements", Global Forum on Agriculture Doc No GFAR/00/17-04-04 available at http://www.egfar.org/documents/conference/GFAR_2000/gf170404.PDF

Vivant Michel (ed.) (2003), *Protéger les Innovations de Demain: Biotechnologies, Logiciels et méthodes d'affaires*, Institut National de la Propriété industrielle, Paris: La Documentation Française

Vivekanandan, P. *et al.* (2004) "Protecting Traditional Knowledge of small, scattered and disadvantaged grassroots innovators and traditional knowledge holders: A Honey Bee perspective and Agenda for Policy and Institutional Change", Paper presented at a UNCTAD_Commonwealth workshop, Geneva 4-6 February, available at http://t0.unctad.org/trade_env/test1/meetings/tk2.htm

Vogt, David B. (2001) "Protection Indigenous Knowledge in Latin America: Maintaining Biological Diversity Creating Relationships and Returning Benefits to Native Communities for Ethnobotanical Drug-Discoveries- Can it Be Done ?" 3 OREGON REVIEW OF INTERNATIONAL LAW 13

Walsh, John P., Ashish Arora and Wesley M. Cohen (2002), "The Patenting of Research Tools and Biomedical Innovations" Presented at the National Academy of Sciences conference on new research on the operations and effect of the patent system; 22 October 2001; Washington (DC), available at: [http://www4.nationalacademies.org/PD/step.nsf/files/walsh2.pdf/\\$file/walsh2.pdf](http://www4.nationalacademies.org/PD/step.nsf/files/walsh2.pdf/$file/walsh2.pdf)

Walsh, John P., Ashish Arora and Wesley M. Cohen (2003), "Working Through the Patent Problem" 299 SCIENCE 1021

Walsh, John P., Charlen Cho and Wesley M. Cohen (2005) "View from the Bench: Patents and Material Transfer" 309 SCIENCE 2002

Weeraworawit, Weerawit (2003), "Formulating an International Regime for Genetic Resources, Traditional Knowledge and Folklore: Challenge for the Intellectual Property System", 11 Cardozo JOURNAL OF INTERNATIONAL LAW AND COMPARATIVE LAW 769

WHO (2000) *General Guidelines for Methodologies on Research and Evaluation of Traditional Medicine*, Geneva: WHO/EDM/TRM/2000

WHO, IUCN and WWF (1993), *Guidelines on the Conservation of Medicinal Plants*, Gland, (Switzerland): IUCN

Wilder, Richard (2001) "Protection of Traditional Medicine, World Health Organization", Commission on Macroeconomics and Health Working Paper Series, Paper No. WG 4: 4

William Fisher (2001), "Theories of Intellectual Property", in Stephen Munzer, (ed.), *New Essays in the Legal and Political Theory of Property*, Cambridge: Cambridge University Press

Wilson, E.O. (ed.) *Biodiversity*, Washington D.C.: National Academy Press

WIPO (1997), *An Introduction to Intellectual Property, Theory and Practice*, London, The Hague, Boston: Kluwer Academic Publishers

WIPO (2002) *Inventory of Online Databases Containing Traditional Knowledge Documentation Data*, WIPO/GRTKF/IC/3/6

WIPO (2001) *Intellectual Property Needs and Expectations of Traditional Knowledge holders*, WIPO Report on Fact-Finding Missions on Intellectual Property and Traditional Knowledge (1998-1999), Geneva

WIPO (2002), *Inventory of Traditional Knowledge-Related Periodicals*, WIPO/GRTKF/3/5

WIPO (2002), *Technical Proposals on Databases and Registries of Traditional Knowledge and Biological/ Genetic Resources*, WIPO/GRTKF/IC/4/14

WIPO (2002) *Traditional Knowledge - Operational Terms and Definitions*, WIPO/GRTKF/IC/3/9

WIPO (2003) *Comparative summary of Existing National Sui Generis Measures and Laws for the Protection of Traditional Knowledge* WIPO/GRTKF/IC/5/INF/4

WIPO (2003) *Comparative Summary of Existing National Sui Generis Measures and Laws for the Protection of Traditional Knowledge*, WIPO/GRTKF/IC/5/INF/4

WIPO (2003), *Defensive Protection Measures Relating to Intellectual Property, Genetic Resources and Traditional Knowledge: An Update*, WIPO/GRTKF/IC/6/8

WIPO (2003) *Information on National Experiences with the Intellectual Property Protection of Traditional Knowledge*, WIPO/GRTKF/IC/5/INF/2,

WIPO (2003) *Traditional Knowledge, Traditional Cultural Expressions, and Genetic Resources: The International Dimension*, WIPO/GRTKF/IC/6/6

WIPO (2004), *Development of Classification Tools for Traditional Knowledge*, WIPO/IPC/CE/34/8

WIPO (2005) *Protection of Traditional Knowledge: Revised objectives and Principle*, GRTKF/IC/8/5

WIPO (2006) *The Protection of Traditional Cultural Expressions/ Expressions of Folklore: Revised Objectives and Principles*, WIPO/GRTKF/IC/9/4

Wood, A. et al. (no year) "Socio-economic Root Causes of Biodiversity Loss in the Philippines", Summary

World Conservation Monitoring Center (1992) *Global Biodiversity*, London: Chapman & Hall

Wynberg R. and Swiderska K. (2001) *South Africa's Experience in Developing a Policy on Biodiversity and Access to Genetic Resources*, London: International Institute for Environment and Development (IIED) and Earthprint Ltd

Yano Lester I. (1993), "Protection of The Ethnobiological Knowledge of Indigenous Peoples" 41 UCLA LAW REVIEW 443

Zerbe, Noah (2005), "Biodiversity Conservation and Protection of Indigenous Knowledge: Analyzing the Emergence of a Legal Framework for Access to Biodiversity, Benefit Sharing, and Intellectual Property in Africa", in LES CARNETS DU CENTRE DE PHILOSOPHIE DU DROIT, Université catholique de Louvain

Zerbe, Noah (2005) "Biodiversity, Ownership, and Indigenous Knowledge: Exploring Legal Frameworks for Community, Farmers and Intellectual Property Rights in Africa." 53 ECOLOGICAL ECONOMICS 493-506

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