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ECONOMIC ISSUES IN ACCESS AND BENEFIT SHARING OF GENETIC RESOURCES: A FRAMEWORK FOR ANALYSIS

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FOREWORD

Access and benefit sharing (ABS) of genetic resources has been part of the discussions concerning implementation of the Convention on Biological Diversity since its signing at the Earth Summit (1992). With the recent acceptance of the Bonn Guidelines at the 6th meeting of the Conference of the Parties, the discussion moved to a new phase in giving consideration to actual implementation of ABS frameworks. From a public policy perspective, this phase requires careful consideration of some of the underlying issues that will weigh heavily on the resulting social benefits. This paper attempts to sort through many of these issues by using an explicitly economic framework for considering matters that policy must deal with.

The issues identified in this paper also permit a careful *ex post* consideration of implementations of ABS and the factors that contributed to its success or failure. From that perspective, this paper is a useful guide and starting point for additional work that would review cases where policies have been established.

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1. Introduction

The three main objectives of the Convention on Biological Diversity (CBD) are: (i) the conservation of biological diversity, (ii) the sustainable use of its components, and (iii) the fair and equitable sharing of benefits arising out of the utilisation of genetic resources. Access and benefit sharing (ABS) of genetic resources, therefore, features prominently as a central objective of that international agreement. The CBD also contains provisions to encourage the equitable sharing of the benefits arising from the utilization of knowledge, innovations and practices of indigenous and local communities. These, and other, provisions within the CBD are intended to affect the exchange of resources and knowledge related to biodiversity goods and services. At the Conference of the Parties (COP) to the CBD's sixth meeting (The Hague, April 2002), the Parties adopted the Bonn Guidelines to facilitate and promote common approaches to implementation of ABS.[1] Some countries have also begun to act to establish domestic laws and regulations concerning ABS.

Biological prospecting for genetic resources (a channel for ABS) was one of the original motivations for establishing the Convention on Biological Diversity (CBD, 1992). By instituting formal mechanisms for ABS for genetic resources, it was hoped that additional financing for conservation of these resources could be procured. In other words, ABS was seen as a means for achieving conservation and sustainable use of biodiversity by increasing its indirect economic value.[2] In that original context, however, bioprospecting was thought of primarily in terms of pharmaceutical products. In fact, there is a broader context for bioprospecting: it can be viewed as the search among naturally occurring organisms for new products of industrial, agricultural, and pharmaceutical value (Simpson and Sedjo, 1996, p. 1).[3] This broader perspective underlies the observations made in this paper.

In attempting to implement ABS for genetic resources, however, it is necessary to understand some of the underlying characteristics of the policy context. Policy related to genetic resources exists in a broader setting of policy covering biodiversity. Both biodiversity, and by implication genetic resources, have characteristics common to public goods: they provide benefits to economies that are unpaid and difficult to market. The paper explores the policy issues related to the public-goods characteristic of genetic resources.

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1. The Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization – COP VI Decision 24.

2. During the 1990s a number of pharmaceutical companies withdrew from bioprospecting, while others made high-profile enhancements to their programs. The net effect, however, was to reduce the demand for bioprospecting activity, so that it now rests at historically low levels. The current situation is not without precedent. Since the middle of the previous century there have been a number of swings in demand for services and resources from biodiversity that have created long periods of high and low demand (Ten Kate and Laird, 1999).

3. This study, however, can be also read in the light of ex-situ collections of genetic resources.

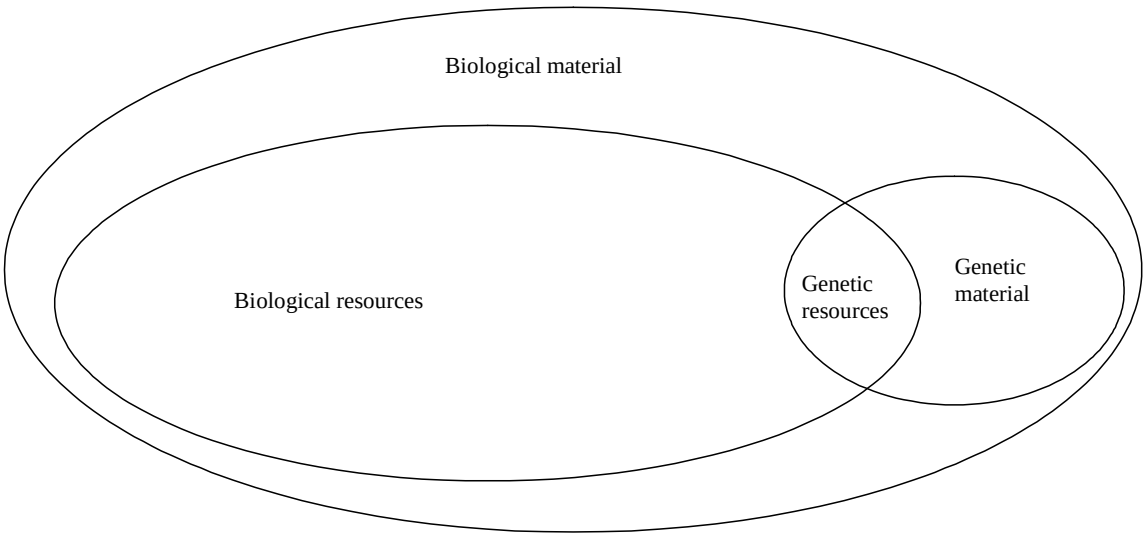
The goal of the paper is to provide an economic-based analytical **framework** that can be used to reflect on the ABS issue. It begins its treatment of the subject from the perspective **economic principles,** and outlines what can be contributed in terms of the **efficiency** of outcomes. It should be noted at the outset that ABS is primarily about achieving **equity** in the utilisation of genetic resources (in many cases developed countries have the know-how, but developing countries have the resources). It is important to make a clear distinction between those elements of the ABS policy problem that are primarily focused on efficiency objectives and those which pertain primarily to equity concerns. The framework outlined in this paper will contribute to making that distinction. Pursuing equity goals should be done in a way that minimises impacts on efficiency. By making this distinction and outlining some of the areas where efficiency can be improved — such that human welfare and environmental outcomes are *both* increased simultaneously (improvements in efficiency) — next steps toward improved ABS policy can be more clearly explored. Issues that are already important in implementation — such as transaction costs, etc. — should be part of an immediate, more practical, follow-up effort. Such work could help guide development of ABS in countries that have not yet implemented an ABS framework, as well as help to refine those that are already in place.

An important caveat is that the framework outlined here does not explore the surplus social benefits that may exist in the goods and services that are *produced* from genetic resources. This benefit is the difference between what individuals **actually** pay for a product or service, versus what they would have been **willing** to pay. This difference can be significant if the social value of the good or service far exceeds the price at which it is sold in the market. For example, life-saving products are worth considerably more to society than their cost at the pharmacy.

Although ABS has been one key focus of the CBD, other international organisations have also been contributing to its development. The World Summit on Sustainable Development (Johannesburg, 2002), for example, called for reductions in the rate of biodiversity loss by 2010 through a number of initiatives (including ABS) that would help developing countries alleviate pressures on biodiversity. The Food and Agriculture Organisation negotiated the International Treaty for Plant Genetic Resources for Food and Agriculture which will, (when ratified) establish mechanisms for the sharing of benefits from plant genetic resources — even for traditional knowledge. The World Intellectual Property Organisation has also established an inter-governmental committee which is in the process of developing a database of contractual practices relating to ABS.

For clarity, it is useful to review some CBD terminology. In that terminology, **genetic resources** are a subset of **biological resources**. That is, biological resources 'include(s) genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.' Genetic resources, then, are understood as 'genetic material of actual or potential value.' That is, genetic resources are seen as a subgroup of **genetic material**. Genetic material 'means any material of plant, animal, microbial or other origin containing functional units of heredity.' Figure 1 illustrates the relationship between these concepts.

Figure 1. Classification of genetic resources according to the CBD



Section 2 discusses the economic principles that are most applicable to analysis of the ABS of genetic resources. This is followed by consideration (Section 3) of some of the related factors that influence the application of those principles. The focus is on access to genetic resources in section 3.1 and on the economics of information and innovation in Section 3.2. Section 4 then moves closer to the implementation of ABS, by looking at issues that are likely to be unique in each national circumstance. This part of the paper is complemented by an Annex that provides some case-study information from country experiences with the sharing of benefits.

2. Economic principles involved in the ABS of genetic resources

This section provides some of the analytical foundation for the discussion that follows. It is provided in order to give a description of the salient characteristics underlying markets for genetic resources, and to underpin the need for policy development in this area. It is necessarily stylised, given the intention to understand the primary factors concerned with ABS of genetic resources. Nevertheless, it serves as a useful backdrop to the more immediate issues such as transactions costs, contract negotiations, etc., which are discussed in subsequent sections.

Market failure (used here according to the strict *economic* definition of the inability of a system of markets to allocate certain goods or services at the socially optimal level) is a primary economic justification for policy intervention. In markets for goods and services from biodiversity (and more specifically genetic resources), market failure can lead to incorrect levels of use and conservation. This implies that competing economic, environmental, and societal objectives are not being traded off at the socially optimal levels — it is being over utilised in one function and under utilised in the others. Market failure in ABS of genetic resources can occur in the presence of: (1) non-excludability; and/or (2) non-rivalry in consumption. These two criteria characterise public goods. Genetic resources are not a clear-cut example of public goods; many, but not all of their characteristics and values have the attributes of public goods. Non-excludability is often closely related to lacking (or not well-enforced) property rights, which is often the case for genetic resources. This is most commonly manifested where there is 'open access' to genetic resources. Non-rivalry is often related to goods or services that can be costlessly

replicated. Another reason that can lead to market failure in the case of ABS of genetic resources is (3) imperfect information.[4]

2.1 Excludability

If a good or service is excludable, 'producers' can restrict its use to those consumers who are willing to pay. On the other hand, if the producer is unable to prevent others from using a good or service once provided, it will impact on the market because individual's willingness to pay (WTP) will be reduced. When the firm cannot sell sufficient quantity of the good or service to cover the development costs, the firm will no longer engage in that activity and social welfare may be reduced.

Two levels of excludability for genetic resources are identifiable. The obvious one is that of *physical access* to the resource. Since the state has authority to grant or deny access to its genetic resources (recognised under the CBD), this can, in principle, make genetic resources excludable, in the particular case where genetic resources are endemic to only one country. Excludability will often not be possible in cases similar to most domesticated and cultivated genetic resources. In this case, the resources have been widely circulated, increasing the number of countries that develop a rich diversity for the species concerned, but also increasing the number of countries that have the same genetic resources under *in situ* or *ex situ* conditions. In addition, legal excludability does not automatically establish economic excludability — the legislation must be enforceable (and enforced). Whether we have exclusion of genetic resources in practice, is therefore an open question.

The *information* embodied in genetic resources can also be excludable when the technology to extract this information is not available. This gives a second level of excludability founded on research 'know-how', technical equipment, and financial resources. However, once a product based on that information is developed and sold in the market, other parties may be able to copy the information cheaply and quickly. So long as competitors are not successful in copying the product, the first mover (pioneer) can secure monopoly profits. As soon as the product is copied, those profits will diminish, and may even vanish as competition drives prices down. When profits are not sufficient to cover R&D costs, *ceteris paribus* firms will no longer be able to engage in this type of R&D. As discussed more fully below, intellectual property rights (IPRs) can help secure legal excludability, thereby potentially creating monopoly profits for their holders.[5] However, two caveats are worth pointing out here. If a product can be easily copied and detection is difficult, an IPR regime becomes equivalent to a form of moral suasion — an ethical issue rather than an economic one. In such a case, IPRs may fail to induce increases in R&D activities, since protection to the innovating firms may be insufficient. On the other hand, IPRs may not

4. Market failure can also involve: (i) externalities; or (ii) monopoly power, *Externalities* exist when an activity undertaken by one individual or group of individuals has a (positive or negative) effect on another individual or group, and those affected neither compensate (positive externality) nor are compensated (negative externality) by those causing the externality (OECD, 1999a). That is, the external effects caused by those responsible for the action are not taken into account in their decision-making. While also applying to biodiversity in general, externalities may not be directly relevant for ABS of genetic resources. *Monopoly power* may cause market failure by the power of a producer to set a profit maximising price. Such price setting power contradicts the basic assumption of a competitive market, wherein firms are price takers, (i.e. have no influence on the market price). The monopoly price will be higher than the market equilibrium price and the quantity of the good provided will also be lower. Since consumption and production are less than the efficient amount, a dead-weight loss in welfare occurs. Again, this criterion for market failure does not generally qualify for the study of ABS, even though there may be some companies that have influence on market prices.

5. As shown by the vibrant markets for copied products, IPRs are not totally successful in ensuring excludability.

matter when innovations are very difficult to copy. When sufficient protection exists in the nature of the product, such that potential entrants cannot hope to recover the costs of duplication (fixed or otherwise), IPRs will fail to induce increases in R&D, since they provide little additional protection.

The issue of excludability for genetic resources is linked to the problem of open access to source material. Open access can result in agreements governing access and use that are vulnerable to free entry, undermining the exclusivity of any contract. Genetic resources from large rainforests, for example, would be subject to open access.[6] Since ABS legislation typically grants access to genetic resources in exchange for benefit sharing, the value of an agreement in terms of benefits potentially shared would have to be reduced if the access is not exclusive. Enforcement of ABS legislation can therefore be crucial to the success of ABS contracting.

Dealing with open access, however, is not purely a problem of creating exclusivity with a given country. When an ecosystem is sufficiently large that it exists within the boundaries of more than one country, there may be no incentive to gain access under the auspices of an ABS agreement with one country, if the others do not require such an agreement. In such cases, ABS implementation by host countries may have to be cooperatively developed by all potential sources of access to particular ecosystems, in order to ensure excludability.

Exclusive access contracts may also not be suitable in circumstances such as non-endemic genetic resources, or many genetic resources used in agriculture. Breeding processes in agriculture currently use dozens of genetic resources to create a new variety and thus cannot be based only on exclusive access.[7] Here, the challenge is to combine facilitated non-exclusive access to the different genetic resources needed for breeding with the sharing of the benefits arising from the commercialisation of the resulting variety - which depend on adequate IPRs that ensure exclusivity on the commercialisation of this variety.

For the sufficiently innovative pioneer, genetic information can be made excludable by staying ahead of competitors, as well as through IPRs. The risk for the firm comes from the fact that biological resources (and within this category, genetic resources) remain non-excludable until an advanced stage of development has been achieved with the information, so that it can be patented.

2.2 Rivalry

Rivalry in use or consumption is the other criterion for private goods, and for well - functioning markets. Use is ‘rival’ if one person’s consumption of a good reduces the quantity available to others. Non-rivalry means that commodities or services can be made available to others at no extra cost — even when supplied to one person. This means that use of the good/service does not reduce its availability to anyone else. The classic example of this is a blueprint. In the context of genetic resources, the structure of an active chemical compound would be an equivalent example. Once that structure is known, it can be used in many places simultaneously, with each additional use having no impact on the previous user.

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6. For this paper, ‘open access’ is limited to ‘genetic resources’, and does not include the broader ‘biodiversity resources’. Open access to biodiversity resources is be associated with resource rents and eventual depletion of the resource in question. Bioprospecting is not likely to cause problems of extinction, but may be a means of conserving biodiversity.

7. As recognized by the UPOV plant breeders’ right, that confers exclusivity on the commercialisation of the new variety only, leaving it freely accessible for further research and breeding, and by the newly adopted International Treaty on plant genetic resources for food and agriculture. The genetic resources covered by the system put in place by the Treaty are managed partly as public goods.

The issue of rivalry arises with genetic resources because information (intellectual property) is an important component in the creation of many related commercialised products. For firms in some industries, the information embodied in intellectual property can be the single largest marketable asset that they own. This is particularly true for some high technology sectors — such as drug companies who either synthesize new molecules themselves, or use genetic material to find and produce active ingredients. Non-rivalry in the use of that intellectual property means it can be replicated and used by others at no additional cost.

Intellectual property rights are intended to secure legal excludability, thereby coping with the problem of non-rivalry. In the process, however, these rights create monopoly profits for their holders. For society as a whole, therefore, IPRs essentially trade off a source of market *failure* for a source of market *inefficiency*. The source of market failure is the fixed costs that are incurred by only one firm in creating intellectual capital - these costs will not be undertaken if they cannot be recovered. Allowing the establishment of temporary monopolies through IPRs can mitigate this market failure — but the more inefficient market structure that results introduces its own (hopefully smaller) welfare loss. This rationale for IPR protection, however, needs to be put into the context of the many circumstances in which they are used. One important factor is the ease with which products are copied: this will be an important determinant of the effectiveness of IPR since protection will be less effective when duplication is costless. Another factor will be the level of economic development that a country has achieved. For example, the international community recognised in the TRIPS agreement that Least Developed Countries should not be required to apply TRIPS for at least ten years. Historically countries have tended to strengthen their IPR regimes progressively as they have developed economically, both in the now-industrialised countries and, more recently, in East Asia (Commission on Intellectual Property Rights, 2002). The optimal nature of the IPR regime will thus vary according to a country's economic and social circumstances.

Box 1. IPRs and economic development

To understand some of the reasons behind the gradual process that the TRIPS put in place, consider the variability in the global distribution of intellectual capital. For countries that are technologically advanced (i.e. have substantial endowments of intellectual capital), IPR protection is more likely to have a positive impact on the economy since it ensures a return to a form of capital. On the other hand, for those economies that are predominantly consumers of protected intellectual property (i.e. low-income countries), the impact may, in the short-run, turn out to be negative. The longer-term impact, of course, would be that even low-income countries would benefit from enhanced foreign direct investment and the increases in trade that it ultimately brings — that is why the TRIPS process is gradual. As the UK's Intellectual Property Research Programme has observed[1], empirical validation of these observations may be difficult since, even in industrialised economies, the link between IPRs and research and development decisions by firms remains tenuous.

With respect to trade, situations can arise where trade appears to be adversely impacted by IPRs even though the actual effect was positive. When IPR protection is weak, for example, large multi-nationals may only sell goods in a particular market if those goods are difficult to reproduce. A strengthening of the IPR regime may induce companies to begin to produce it locally (either under license, or in local facilities they own). When this happens, domestic production will reduce trade in that good and the IPR will appear to be the cause — the local economy will be better off but the trade statistics would suggest otherwise. The economics of innovation and information, therefore, carry many nuances that impinge on outcomes — nuances that need to be carefully considered when discussing/anticipating the potential impact of IPRs for ABS regimes.

[1] ESRC Intellectual Property Research Programme (http://info.sm.umist.ac.uk/esrcip/background.htm).

An independent economic rationale underlying support for patents is that a patent constitutes a means by which society can promote dissemination of information about inventions. In order for an inventor to obtain a limited term monopoly, he must reveal to the public the knowledge necessary so that others can replicate the invention and can build upon and commercialise the invention upon expiration of the patent term. Without this incentive, an inventor would be more likely to keep secret the knowledge of how to make the invention, either without IPR or protected by trade secret laws. In the case of genetic resources, without the information provided by the inventor in the patent application, the knowledge of how such an invention was made might never (or very late) come to light. Notice, however, that with regard to genetic resources, this argument is more subtle. Some aspects of the patented matter may be already known in the form of traditional knowledge, for example, the healing properties of a plant. A patent, or other means, in that case serves to allow greater dissemination of existing information.

For firms from industrialized economies engaged in the search for genetic resources, the decision to commit resources to that search will depend on the incremental cost of bioprospecting (and the associated R&D effort) and the benefit (now and in the future) of increased profit *for the firm*. The relevant IPR regime for those companies could be that which is implemented in the dominant market for their output — the level of bioprospecting, therefore, would be sensitive to forces outside the host country. Nonetheless, there would still be an important role for the IPR regime in the country where the genetic resources are located.

Under the TRIPS agreement, all members of the WTO must provide patent protection for at least 20 years from filing date. IPRs can include, among others, copyrights, trademarks, service marks, geographical indications, industrial designs, patents, layout designs for integrated circuits, and trade secrets. With regards to genetic resources, the TRIPS Agreement specifies in Article 27 which goods are patentable: sub-paragraph 3(b) requires signatories to 'provide for the protection of plant varieties' either by patent or by other system. However, that sub-paragraph also calls for review of exemptions of patentable products, and for discussions to continue as part of that process.

Since national law creates IPRs, they apply only in a single national jurisdiction. To address this issue, there has been a focus recently on the need for international co-operation to ensure global protection of intellectual property (World Bank, 1999, p. 33).

In the pharmaceutical industry, the need for IPR protection is clear given the long and complex development process. Development of a product involves identification, isolation, testing of active ingredients, ensuring safety for human use at various strengths, and developing a usable form. Analysis focuses on information to be gained from characteristics that evolved within a living, dynamic environment, the purpose of which is to build a library of successful strategies in an evolutionary perspective.[8] As mentioned earlier, biological resources can either be used as genetic resources (informational inputs embodied in a physical sample, combined with other forms of capital), or they can be used as direct physical inputs into production. For uses as genetic resources, efforts will tend to look at those genetic resources with the most information readily available, such as *ex-situ* collections in botanical gardens, or indigenous knowledge (OECD, 1999b, p. 9).

8. Biological (and thus genetic) diversity in this sense can be seen as one-time endowment from the evolutionary process. The aggregation of differences that systematically accrued out of the lengthy evolutionary process and thus represent half-billion years of experience within existing, interrelated, ecosystems cannot be substituted by human effort. It is these relative rates of specialization and extinction, and their occurrence within complex and interrelated systems, that make biodiversity something of a non-renewable resource. Individual biological organisms can, of course, be viewed as renewable resources. Thus, biodiversity can be seen as *the* natural resource which exists at the interface between the spheres of renewable and non-renewable resources (Swanson, 1994).

Given the informational value of genetic resources, selling access to those resources may be regarded as the sale of an opportunity for innovation (traditional knowledge included). Thus, the general literature on creation and dissemination of innovations is helpful in understanding incentives for the contracting of genetic resources. One of the general lessons we learn from that literature is that users of genetic resources should be granted exclusive rights, such as patents, for final product sales. If exclusivity is not granted, companies may not have sufficient incentives to invest in the 'right' (i.e. socially optimal) level of R&D. An important question is whether such exclusive rights should cover not only the commercialization of the final product, but also all its other uses — especially in the case where it is itself a genetic resource. This is particularly relevant with breeding for food and agriculture: where the industrial process resulting in a new variety generally consists of crossing several dozens of genetic resources — the majority of these involving new industrial varieties (generally protected by intellectual property rights). Landraces are generally used only for the inclusion of one specific trait. This explains why property rights related to varieties — which confer exclusivity on the commercialization of the new variety while leaving it freely available for further research and breeding — have been developed and adopted more widely than has the patent system for plant varieties.[9]

2.3 'Club goods' and the commons

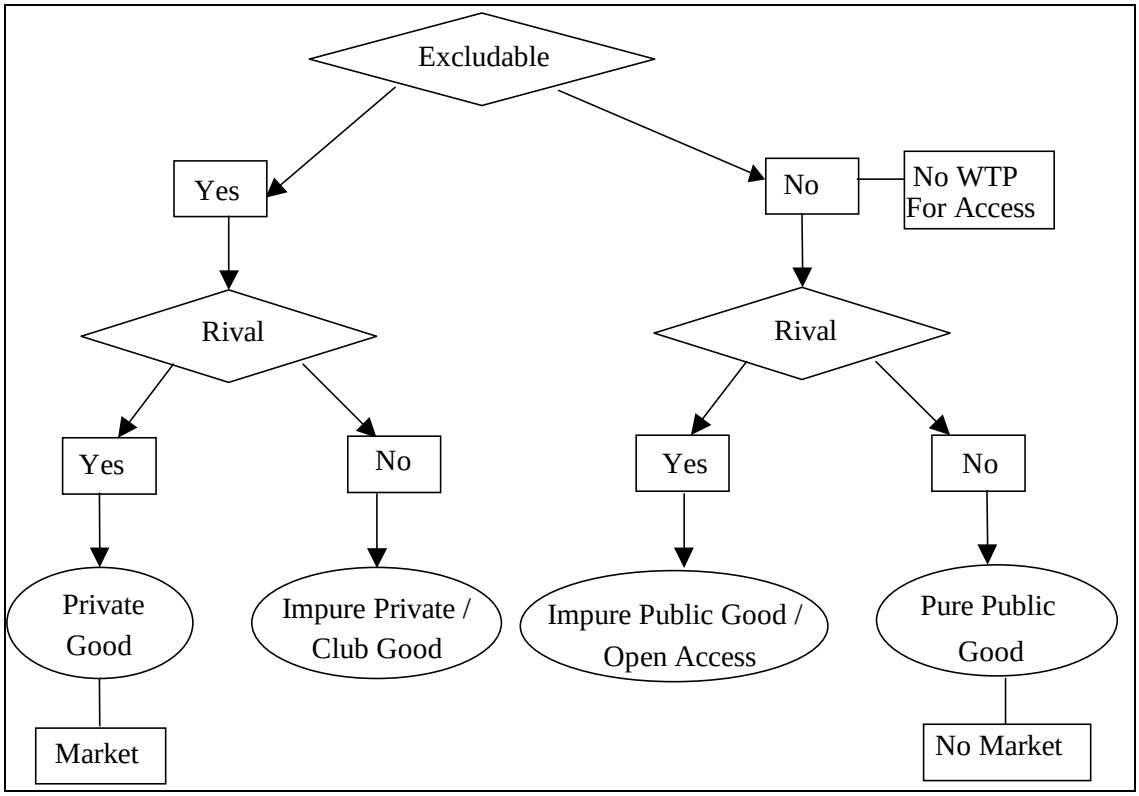
Combining the two concepts of excludability and rivalry, we get two results with interesting implications for market outcomes. First, when we have excludability combined with non-rivalry (but there is an externality that arises out of its use), we have a 'club good'.[10] Club goods pose a problem for setting the optimal price for entry because increasing membership leads to increases in the associated externality. Once entry has occurred, there is no restriction on use, and therefore little or no ability to control the externality, so the only possible restriction concerns *who* is allowed to enter. The entry price is, therefore, set to balance the gain from additional entry to the loss from increased use. Second, when there is rivalry in use but the good or service is non-excludable, we have the problem of the 'commons in open access'. This may take the form of common property that is shared in an uncontrolled manner amongst its owners but others can be excluded; or it may take the form of an open-access regime where it is difficult to put any restriction at all on use. Regarding the ABS of genetic resources, both the problems of the commons as well as that of club goods may apply. Implementation of an ABS regime that does not give *exclusive* access and rights to genetic resources will lead to a club good. On the other hand, prior to implementation, there will be a problem of the commons. It may continue even with an ABS regime. For example, ABS that gives unlimited access, but requires disclosure of products found — possibly for future negotiations — would engender the problem of the commons: each person's use would fail to account for the impact that it has on others.

While these definitions serve to highlight that club goods and common goods are defined by the *degree* of excludability and rivalry that they engender, Figure 2 presents a useful simplification to diagrammatically illustrate these concepts. It shows in binary form the various combinations of the rivalry and excludability problems.

9. See UPOV and TRIPs assessments on IPR systems relating to plant varieties.

10. Sandler and Tschirkhart (1997), give a review of 'club' theory. 'Club goods' are also discussed in OECD (1999a).

Figure 2. Classification criteria rivalry in consumption and excludability



Most goods and services that would be potentially covered by an ABS policy are neither pure public goods nor pure private goods. They therefore fall into this mixed category of club or common goods. The challenge for policymakers in implementing ABS is thus to find the right *balance* between treating genetic resources as either public or private goods, (i.e. setting policy for the correct degree of excludability and rivalry).

2.4 Information

The third criterion for market failure relates to information asymmetries. The existence of knowledgeable buyers and sellers is a standard assumption for competitive markets. Informed buyers/sellers help the price mechanism achieve an efficient allocation of scarce goods/services by ensuring that transactions refect the full range of preferences of market participants. However, the ABS of genetic resources is prone to less-than-perfect information. Information in this context will mean both *technical knowledge* (i.e. know-how), as well as knowledge about *attributes*, such as the quality of a product (i.e. quality of samples), the nature of the interest in the genetic resource, diligence of a worker, and creditworthiness. Knowledge which is incomplete (i.e. private, or not known to all parties involved), causes problems known in economics as those of principal-agent[11], moral hazard[12], and adverse selection[13].

11. 'Principal-agent' problems classify situations in which interests of a principal entity assigning a task and the agent fulfilling this task, differ. The principal has interests in good performance, but appoints an agent to act in his place. The principal cannot fully control what the agent does. Since the latter has different incentives governing his action, this leads to problems for the former.

Problems of imperfect information can be found in all three of the related sources of economic value: genetic resources, genetic information, as well as traditional knowledge.

Any private information (information that is not held by all parties — or in the extreme, is held by one party only) gives rise to information asymmetries. In the case of ABS of genetic resources, two-sided private information is common. On the side of the user of genetic resources, the informational advantage may concern the underlying potential interest in genetic resources, costs of R&D, and the attractiveness of available alternatives. This informational advantage for the user is likely to be strongest since the information contained in genetic resources is complex and the provider may not know the research objectives of the user (i.e. the potential market for products being developed). It may be particularly significant if the user is an industrial firm - one that has some research capacity, but is limited in its ability to plan over the long term. A firm with a shorter-term outlook will not be in a position to cultivate the long-term gains that come from: reputation-building with potential suppliers of both genetic resources and traditional knowledge, or cultivating relationships with consumers of its products. A short-term outlook, however, is not necessarily the result of myopic management — financial markets that are unable to make adequate financing available to a firm would limit its manager's planning horizon.

On the side of the provider, private information may exist about reliability, quality, diversity, and other functions of the information and material to be supplied. Some of these sources of private information are more readily dealt with in a negotiating context. For example, providers of genetic resources can be subjected to ex post verification — which can become part of the contractual agreement when there is some doubt. In such cases, payments can be scheduled to reflect resolution of the information asymmetries. Many other circumstances exist in which contingency of payments could help resolve perceived asymmetries of information — or uncertainty of outcomes. One problem, however, is that verifiability may be difficult. Royalty payments that are linked to commercial success can deal with uncertain outcomes, but they are unlikely to be universally applicable. The difficulty arises in those cases where 'commercial success' is not easy to verify — especially when fixed costs are high and ill-defined (so marginal revenue minus marginal cost poorly reflects 'profitability'). This is because a company that must make royalty payments based on profitability will want to include *all* fixed costs that contributed to developing and selling the product — which can lead to disagreement, even in the best of circumstances.

One situation that arises easily is where the provider sees examples of successful products that were derived from genetic resources and fears setting a price for access (or material) that is too low. The resulting price may be high enough to force out users at the 'low' end of the market. Dealing with this type of situation may involve making the bulk of payments for access contingent upon the discovery and usability of new products — a fixed payment per unit sold, rather than being based on profitability. One problem with these contingent payments, however, is that when the host country is a developing economy, the needs for income to help finance development are immediate. With long research and development phases — and then even longer periods over which the income will accrue — the opportunity to make significant contributions to social improvements may be missed. Information asymmetries can therefore, lead to serious problems in the ABS of genetic resources, including a risk of discouraging the provision or use of genetic resources by interested parties.

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12. 'Moral hazard' describes situations in which agents alter their behaviour in response to an offer from another agent that was not meant to alter that behaviour. Insurance or warranties are contractual arrangements that often risk providing incentives of this sort. For example, insurance may stimulate careless behaviour by some recipients, affecting the costs of all recipients.

13. Asymmetric information provides incentives for only the worst risks or lowest qualities responding to the offer of an offering agent. This is referred to as 'adverse selection'. It leads to additional market failures, because it increases total costs to society at large.

Adverse selection is another problem arising with asymmetric information.[14] This problem is based mainly on the unobservable qualities of individual items to be traded. The lack of observability of certain characteristics adversely affects both the volume and quality of items traded. In the case of bioprospecting, this may occur when the quality of samples or those providing indigenous knowledge, are not known before agreeing to an ABS contract. Though less common, the same logic applies in reverse from the perspective of those providing the knowledge. The reliability of an institution seeking access to genetic resources may not be known, leading to concerns regarding fulfilment of royalty agreements. The former case is more common: in general, a user is not able to observe the qualities of a provider. With unobservable qualities, the market price is mostly informed by the average quality — giving rise to an incentive for high quality providers to opt out of the market (the average price will be too low). This phenomenon of adverse selection is known as the market for 'lemons.' The classic example is the used car market, in which asymmetric information causes a simplistic equilibrium outcome to involve only trading of the worst cars (more sophisticated models can derive slightly different outcomes but the essential result remains the same). For ABS, this translates into the danger of excluding high quality providers from market contracts by offering insufficient benefits. Market price may fail to convey sufficient information: it may therefore need to be supplemented by additional, institutionalised, sources of information. When these sources of information are based in a particular country, they may serve the additional purpose of identifying providers of traditional knowledge — thereby reducing search costs.

Reputation-building is a means of signalling high quality (and thus, ameliorating adverse selection problems). However, it is costly in two particular situations. The first occurs when there are decentralised market institutions and a large number of direct sales by small sellers (the market is dispersed). The second, occurring when there is a low frequency of trades in highly developed markets (the market is thin), takes time to build a reputation. In these circumstances, it may be preferable to centralise the trading process (e.g. in the form of establishing a national agency), and to develop standards that signal high-value or low-risk. This has already occurred in several countries, for example in Brazil, and has led to the development of some large institutional suppliers, such as Bioamazonia or INBio. Since the number of transactions has been modest and the market is still under development, these institutions may be in dominant positions - which facilitates reputation-building. Furthermore, setting standards might be feasible for access-seeking institutions and big research centers in provider-countries. For local communities and indigenous people, the main challenge is to incorporate their traditional knowledge into such institutional contexts.

One form of 'industrial signalling' is to label a group of products. For example, a label could signal compliance with ABS legislation and fairness of contracts — and thus extract consumer surplus from those willing to pay for a 'fair trade' label. Publicly-observed and favourably-viewed contracts, even though not entirely revealed, can help to establish a good ABS reputation for both user and provider of genetic resources.

Another option for alleviating information asymmetries is for an incompletely informed agent to screen potential partners, or get them to partially reveal certain relevant characteristics. Such screening is well-established in insurance markets, with different types of contracts giving agents an incentive to reveal their true type (e.g. via deductibles). This procedure decreases the risk of the less informed agents when engaging in *ex post* unfavourable market transactions. Screening is unlikely to reveal all information, but is a good start. Those interested in bioprospecting can screen providers of genetic resources by designing contractual benefit arrangements in ways that provide incentives for providers to deliver the best possible outcomes.

14. Discussion is predominantly based on Riley, 2001.

The above discussion has focused on information deficiencies that tend to *reduce* the value of genetic resources. There are also circumstances where it may *enhance* it. INBio, for example, refuses to make public the details of its contracts. By holding royalty rates and other contract details confidential, INBio not only saves itself from having competitors in the provision of genetic resources and related screening services undercut its offers, but it may also be able to negotiate higher royalty rates in future agreements with other companies or institutions (Eberlee, 2000).

2.5 Application to genetic resources

We now look in more detail at the three criteria outlined above for market failure in the context of ABS of genetic resources. Box 2 draws a distinction between three potential targets of ABS policy: (i) biological resources; (ii) genetic resources; and (iii) traditional knowledge.

Box 2. Sources of economic value for ABS

(i) Biological resources

Biological resources span a wide range of characteristics and there exists a wide range of dimensions in which they can be used as inputs into production. For example, trees are a biological resource, which contribute to many of the products and processes created for markets. The mass of the tree may be of interest for its use in wood products such as building material, paper, or furniture construction. Other parts of a tree may be of interest for their molecular-level characteristics — for example, the taxanes in the bark of the Yew tree are directly applicable as an anti-cancer agent. In the context of ABS, biological resources are a potential source of value for ABS, when associated with molecular level structures that do not require the destruction of the tree to harvest.

(ii) Genetic resources

The CBD defines genetic resources as 'genetic material of actual or potential value'. Genetic material, according to the CBD, 'means any material of plant, animal, microbial or other origin containing functional units of heredity.' When particular molecules have value because they are chemically active or structurally novel, the genetic material that contains the code for creating that molecule will be of interest to prospectors. It is, in other words, the genetic information that constitutes the fundamental aspect of the genetic resource. This is because the genetic information may make it possible to find alternative (cheaper) means of producing the molecule of interest.

(iii) Traditional knowledge

Traditional knowledge is in most ways different from the above two forms, but has some similarities to (ii), in that it is the information which is of interest. Traditional knowledge is that knowledge which local and indigenous communities have gained over long time spans concerning, among others, uses of certain genetic resources, the way they grow, where they can be found, when it is best to harvest them or how to best make use of, for example, a medicinal plant. This could even be a recipe for a traditional medicine.

For both (ii) and (iii), information covers the service characteristics for research and development, and can assist the production process with knowledge. ABS agreements can be based on all three aspects. However, evidence suggests that traditional knowledge has not played a major role to date in research based on genetic resources. When interest is mostly in information inherent in genetic resources, sustainable use and conservation may not be impaired. The focus can be left on the fair distribution of costs and benefits.[1] But if genetic resources are used as raw material for industry, then sustainable use and conservation issues are likely to become more important.

[1] Normative economic theory may contribute to that discussion. For an overview, see Zajac, 1995.

Looking at the 'rivalry' question for these three categories, we see that both genetic resources and traditional knowledge are non-rival in use. That is, one person's use of the information does not diminish its availability or usefulness to other people. Rivalry induces economic value because it creates scarcity. Full rivalry means that one unit of a good or service must be provided for each person seeking to obtain it. Less than full rivalry means that the good or service can be shared. Since this implies that a user can obtain it for less than the full purchase price, the number of people willing to pay full price for it will be reduced. Rivalry may, therefore, be thought of as applying in varying degrees. Genetic resources (i.e. information) and traditional knowledge are strongly non-rival. Once the information is known, it can be replicated at very little cost. In contrast to this, biological resources are apparently rival in use since they are consumed in the process of producing the good or service. Nonetheless, this may not always convey scarcity if there is a strong potential for substitutes to be developed.

Table 1 summarises the situation facing biological resources according to excludability and rivalry problems. **Biological resources** exhibit the characteristics of non-excludability, but rivalry-in-use when access cannot be restricted. They can, therefore, be characterised as impure public goods with open-access problems. Enforcement of excludability to biological resources can be done through property rights, thereby solving open-access problems. However, enforcement can be difficult and costly. **Genetic resources** may be excludable (second level), but are non-rival. This makes them a special form of a club good; (i.e. it is difficult to determine what the optimal number of members is for the club). When IPRs do not exist (or are difficult to enforce), genetic information becomes a pure public good. Since **traditional knowledge** exhibits both excludability and non-rivalry, it is also a form of a club good but the 'collective' nature of ownership (as a birthright) gives it some unique characteristics. When ownership is evenly distributed amongst the community, the natural outcome will be for the group to behave collectively as a single source of the knowledge and maximise the community's return to its use. Generalizations regarding ownership, however, are difficult to make since the nature of governance and the social organizations of individual communities are not uniformly predictable.

Table 1. Summary of classification according to excludability and rivalry in consumption

	Excludable	Rival in Consumption
Biological Resources	Yes (if property rights enforceable) No	Yes
Genetic Resources	No (if accessible) Yes (with technological edge) No[1] (without IPR)	No
Traditional Knowledge	Yes	No

Note:

1. Unless there exists a technological edge, this information is potentially non-excludable as well as non-rival. (It can be quickly copied, thereby diminishing incentives to engage in R&D). This will, in turn, prevent society from enjoying potential progress on knowledge. In essence, this is why IPRs exist.

For the three sources of economic value discussed in Box 2, excludability can be variable. In the case of biological resources, non-access is a sufficient condition for exclusion. Because genetic information is

contained in biological resources, open access is the first problem that needs to be addressed concerning the criterion of excludability. Traditional knowledge is distinct from the former two categories in that it does not feature the open-access problem. Traditional knowledge is in principle excludable: either a shaman or an indigenous community is willing to give away some of its knowledge or they are not. In other words, traditional knowledge can only be obtained with the consent of the holder of that information.[15]

2.2.1 Value creation and economic rent

The process of creating value can be elucidated by the concept of economic rents and the theory of information. Rent is defined as a surplus over the costs of: accessing the resources, processing them, and marketing the final product. It is, in other words, the difference between what it costs to produce something (including the return to capital) and what the product sells for in the market. Since competitive markets typically cause the price of a product to be close to the cost of producing the last units, the rent available to producers is often small. Exceptions to this, however, are not uncommon. When other potential producers find it difficult to enter the market (for example, the minimum level of production may be large relative to the market, or when production requires specialised knowledge, or other barriers to entry exist), profits can remain large, even over the long term. This is because the impediments to entry create some scope for the firm(s) to behave as price setters, and therefore to create positive profits. When a specialised input is used which is in limited supply, the rent can be considerable — it is a payment for the specialised factor of production. Economic rent can thus be seen as being created by scarcity — the more scarce an input is, the more likely it will have a high return. However, this scarcity must be coupled with a plurality of uses in order for high rents to occur. An input into production that has only one use and only one buyer will not necessarily generate an economic rent, even when it is in limited supply. Formally, economic rent represents the payment to a scarce factor that prevents it from being used in alternative products.

In the case of ABS of genetic resources, rent can be derived from: biological resources, genetic resources, the know-how of companies, and the know-how of traditional knowledge. In terms of the value of the produced good, there is no ability to distinguish between these. If the criterion of relative scarcity were applied, the conclusion would likely be that scarcity rests in the know-how of the companies who are using the genetic resources to create products. Though its share may be smaller, the genetic resource is clearly a source of value when it is scarce (that is, value above the cost of obtaining it). An important question then becomes: to what extent are providers and users of genetic resources *entitled* to shares of the benefits? Economic analysis can contribute to distinguishing between surplus value that is generated by genetic information, (rather than by research know-how), but the process is problematic (OECD, 1999b). It is even more problematic when several genetic resources, provided by several parties, are used to develop the new product, such as in the breeding sector for food and agriculture. For example, the shares each party will receive will depend on: (1) the relative contribution of each party; (2) the relative scarcity of each party's contribution; and (3) the outcome of the bargaining process they will engage in (OECD, 1997b, pp. 12f.). This latter factor is worth exploring a little further.

When a single firm serves a market, it restricts the quantity it sells to that market, and will thereby collect rents. When that firm is using a scarce input, there will be a unique relationship between it and the supplier of the input. If that input has other uses, the supplier may be able to take all the monopoly rent away from the firm. If, however, the input has no other use, there may be a single buyer facing a single seller. In that case, economic theory tells us very little about how the rents will be distributed between buyer and seller. Though some insights can be gained from theories of non-cooperative bargaining under

15. However, when the same traditional knowledge is known in other communities, excludability may be compromised.

private information, the allocation of rents will, in general be resolved by characteristics that are unique to that market and are, therefore, unpredictable. This is not to say that they are analytically uninteresting — the available literature on non-cooperative bargaining under private information clearly suggests otherwise (e.g. Ulph, 1997). Rather, this observation suggests that circumstances will heavily influence outcomes. Universally applicable frameworks are therefore difficult to derive. Among the factors that will impact outcomes is each party's expectation of future events. When a country is a single source for an input (genetic resource) needed by a monopolised industry, it will be able to capture some of the firm's monopoly rents. However, the short-term gains must be balanced against long-term risks. Technological developments, or even the incentive to continue searching for the genetic resource elsewhere, may undermine long-term demand for the input.

The forgoing paragraphs provide the context for considering value — and its allocation between buyer and seller — in the case of genetic resources. Notice that since genetic resources are often widely available, they display little scarcity *per se*. They may have some characteristics of scarcity when they are located within a single country. Moreover, substitutability may be a problem through the availability of alternative genetic resources with similar genetic characteristics, either *in-situ* or *ex-situ*.[16] These considerations limit the ability of host countries to collect economic rents on their genetic resources. While the CBD has no power over *ex-situ* collections prior to their creation, some institutions have voluntarily implemented a benefit-sharing policy for research and commercial purposes (OECD, 1999b, p. 9). Additionally, genetic resources may be substituted by the know-how of innovators. This includes technological options, such as laboratories and synthesising processes (OECD, 1999b). The contribution of genetic resources to the value-generating process therefore varies in each case with different degrees of substitutability of the genetic resource in question, and the amount of scientific know-how embodied in its further processing.

In the case of traditional knowledge, competition among different holders of knowledge may be limited because of imperfect information regarding what is known, and by whom. Each holder of knowledge may regard the information they possess as being unique and, therefore, scarce. On the other hand, the information regarding the potential market for products made from their knowledge may also not be available to them. The potential for them to claim some of those rents for themselves may therefore be limited.

In the case of genetic resources and their value for pharmaceutical research (i.e. not their existence values or other biodiversity-related services), differing evaluations can be found in the literature, ranging from a value of marginal[17] species tending toward zero[18] (e.g. Simpson, Sedjo and Reid, 1996; Simpson and Sedjo, 1996, p. 2; Vogel, 1996; Rausser and Small, 2000) to arguments for significant values under specific conditions such as patent races (e.g. Rausser and Small, 1998). These estimates are also likely to apply to agricultural, horticultural, cosmetic, industrial, and other areas of research. In general, the marginal value tends to be low, given the large number of genetic resources available, and the low probability of being able to produce a commercially viable product. Where tradition knowledge is

16. The availability *per se* of the same genetic resource from another provider (including both *in-situ* and *ex-situ* sources), and possibly beyond national boundaries, does not establish substitutability. Being able to purchase access to a certain genetic resource from different providers is a normal market criterion, just as one can buy coffee from more than one producer according to price, quality, and other criteria.

17. Simpson, 1998 gives a detailed explanation (aimed at ecologists), illustrating why this is important, when it is appropriate, and which assumptions are made for marginal analysis.

18. The well-known diamonds-water-paradox captures the fact that absolutely essential goods are often available at negligible prices. For example, life could not exist without water, but society will suffer little harm if diamonds are not available. Nevertheless, water is much less expensive than diamonds. The reason for this is that values are determined at the margin.

available, however, the probability of finding something of commercial value may be substantially higher — you can just ask the local healer about plants with potential health benefits.

3. Discussion of the analytical framework: cross-cutting issues

The preceding section identified three reasons for market failure, which apply, in different degrees, to ABS of genetic resources. These criteria provide an economic rationale for government intervention — whether by market or non-market means. This section discusses the applicability of those criteria and the factors that affect their relevance. It therefore moves the discussion away from the theoretical perspective, and toward the more practical level where other assumptions underlying the optimality of markets outcomes must be accounted for when formulating a framework for ABS. Much of the discussion will continue to address issues of excludability or rivalry in one form or another. Table 1 provides a background for identifying which sources of economic value are potentially being addressed when solutions to excludability or rivalry problems are being discussed.

3.1 Property rights regimes

Economic analysis has illustrated that an important step towards solving the problem of non-excludability is the establishment of property rights.[19] Underlying this result is the notion that holders of property rights would be more likely to take a longer-term view of their asset and therefore use it in a sustainable manner. In order for the establishment of property rights to solve certain problems with market outcomes, a number of assumptions need to be satisfied, including having fully informed market participants and negligible transaction costs in trading property rights (among others). Within that conceptual framework, a property right is a means of achieving economic efficiency which maximises the overall welfare of society. Any distributive aspects of allocating those rights need not affect the efficiency of the economic outcome. For ABS, however, the distributive aspect can be the main reason for establishing a property right. It assigns exclusive use, which can then be traded in the market; thereby correcting one of the main sources of market failure. In principle, then, establishing property rights can lead to prescribed distributive outcomes, without necessarily affecting overall economic performance.

Three kinds of property rights applying to genetic resources can be identified: (1) sovereign rights of states over their natural resources, as reaffirmed by the CBD; (2) property rights systems established at the national level (e.g. property rights may be established by different levels of government); (3) intellectual property rights regimes — including patent systems. A fourth form that has been discussed but has not (yet) been codified is the property rights of indigenous peoples over their knowledge, traditions and practices. If all three extant rights categories were well-defined and well-enforced, they would provide strong means to promote ABS of genetic resources. However, national and traditional property rights are either not well defined and/or enforceable. If *enforceable* property rights on genetic resources existed, they would become private goods. In that case, market failure arising out of non-excludability would be satisfactorily addressed.

The caveat, of course, is that property rights must be enforceable — from a technical as well as an economic perspective. As with any good foundation for public policy, 'incentive compatibility' must be a hallmark of the underlying institutions. That is, people must be assumed to behave in their own self-interest and the rules established by government should be such that self-interested behaviour *leads* to the desired outcome. For large corporations that have a very public presence in many parts of the world, a

19. Coase (1960) first pointed out that the simple establishment of property rights could solve some types of market failures.

long-term view of their self-interest would, naturally, tend to lead them toward behaviour that was not seen to be exploitive or otherwise unfair. Enforcement, therefore, is less likely to be an important issue for them as it might be for other parties who are unable to take a long-term view (as per an earlier example, firms that are liquidity constrained).

Enforcement by host countries, however, may not be economically desirable. When enforcement is costly, it may not be a worthwhile endeavour: such as when the social or private value of the property in question is lower than the cost of monitoring and apprehension. Optimality in the enforcement of property rights would call for the incremental expenditure on enforcement to be equal to the incremental forgone revenue from non-enforcement. For many property rights this condition may not be attainable so enforcement will not be optimal — the value of property right may be too low. In such cases, strong IPRs that are clear and well-known may in-and-of-themselves be persuasive moral deterrents to non-compliance.

Beyond enforcement are the issues of establishing markets in which rights are exchanged by knowledgable traders (good information) and, the cost of transacting are negligible. Lack of good information or the presence of transaction costs can cause socially desirable exchanges to fail to materialise. When this occurs, the establishment of property rights might need to be accompanied by complementary measures. Such measures may include more direct regulatory intervention by government; for example, setting standards is sometimes less socially costly than market alternatives when the cost of seeking out information is taken into consideration. Note that these arguments do not suggest that markets will fail to materialise as a result of information problems or transactions costs. Instead, they suggest that, in such circumstances, markets may be improved by some level of government intervention.

The first property right category mentioned above that applies to genetic resources is that of national domain. The provider country of genetic resources must assert its rights over these resources if it is to demand to be compensated for access to genetic resources under its domain. However, not all countries have yet asserted their sovereignty rights by enacting national legislation concerning genetic resources. Asserting those rights, however, only makes it *possible* to gain benefits from the use of genetic resources. An access and benefits sharing regime must also be instituted with provision for a competent national authority and adequate procedures for prior informed consent. These issues are discussed in the Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising Out of the Utilization, which is included in the annex to COPVI Decision VI/24A.

Existing intellectual property rights regimes are applicable to innovations based on genetic resources (see TRIPS agreement Article 27.3b). As noted above, however, the economic rationale for those regimes follows the logic of excludability: use by others is excluded over a well-defined range of potential circumstances in exchange for making the information public. Societal interest in having the information disclosed is to encourage others to build on that technology and improve its usefulness. The dilemma for companies engaged in research and development of genetic resources is that information from such activity will only remain excludable until competitors are able to develop the means to work around its protected elements. If pioneer profits are not sufficient to cover R&D costs, the incentive for innovators will be too weak. This is especially true with the relatively high costs of R&D and short time-delays in producing alternatives (when they are feasible to produce). IPRs provide a policy tool to address potentially insufficient R&D effort caused by non-excludability. Pioneers can thereby secure sufficient returns on products.[20] For bioprospecting, an IPR regime will make each discovery more profitable, and thus permit a higher intensity of search and R&D.

20. The implication is that when the probability of discovering a useful product is low, the gains to those that are discovered must be high. The existence of 'blockbuster discoveries' does not necessarily imply exhorbitant profits – it may signal a high intensity of search and, therefore, reflect compensation for many failures.

Paradoxically, IPRs, including patent systems, are aimed at quickening the pace of innovation, by enticing companies to disclose information, so as to give others an opportunity to develop other products — perhaps even substitutes. The *quid pro quo* for a 20-year patent protection is, after all, disclosure. This means that the inventor must describe his invention in sufficient detail that anyone knowledgeable regarding the subject of the patent can replicate the original invention. IPR structures currently being implemented at the national level that relate to ABS therefore need to be carefully designed to encourage investments in related technologies in much the same way traditional IPR regimes do. This includes investments in all forms of inputs, especially into *in-situ* conservation, since this is the approach most likely to fulfil the CBD's objectives (OECD, 1999b, p. 12f.). One suggestion has been to require patents to provide source documentation when genetic resources are involved (Lesser, 1998, p. 193).[21]

The establishment of property rights for traditional knowledge[22] is, however, problematic. Legal innovations under consideration include collective rights which could potentially address the problem that traditional knowledge is often common to only a small group of people. Such collective rights are not recognised by existing property-rights instruments which were formed to protect the interests of legal entities. The safe-guarding and documentation of indigenous knowledge and practices can be a first step of taking this value into account. One possibility is that a database of traditional knowledge could be created, to which access would be offered in the market. Many problems would exist with such a proposal, and it may be actually unworkable. However, the need for either formalised institutions or clear guidance remains. Some efforts in this direction are described in some existing case studies for the Latin America ICBG program[23]; the Africa ICBG program[24]; and the Suriname ICBG program[25]. This topic has been studied in recent years in a number of international organisations (WTO, WIPO, FAO, CBD, etc.). Notably, the conclusions of the work started in 2001 at the Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore at WIPO are widely awaited.

3.2 Uncertainty and imperfect information

Uncertainty arises when there are random events, and choices must be made before those events occur. When those events have a probability distribution (i.e. when their randomness can be characterised by measures such as mean and variance), rational people can make choices as to what the most likely or least risky outcomes may be. Many features of the stock of genetic resources — and correspondingly, bioprospecting — have the characteristic that they are fundamentally uncertain – little or nothing may be

21. Some caution is, however, needed in this area. The conditions under which IPRs and patents lead to increased R&D are somewhat specialised, making the empirical evidence in favour of the proposition relatively inconclusive. This calls for very careful consideration of measures to ensure a good probability of a favourable outcome.

22. Relevant CBD Articles are 8(j) and 18 (4).

23. The Latin America ICBG program includes provisions in contracts stipulating that, in the event samples or information provided by an ethnobiologist or local people, or material collected from indigenous territory leads to the identification of a sample which is ultimately derived a product, one part of royalties should be deposited into a trust fund for specific conservation purposes.

24. The Africa ICBG program addresses trade secrets in a provision saying that where confidential information is obtained from a source, such as a traditional healer, an agreement providing compensation to the source for disclosing the confidential information is required.

25. In the Suriname ICBG program, contributions from ethnobotanical knowledge could be recognised to be worth 20 per cent of royalties, because 50 per cent of royalties are shared in ethnobotanical collections (which require ethnobotanical knowledge) and 30 per cent of royalties are shared in random collections (which do not).

known about probable outcomes. One is related to the pay-offs from conservation. If there is imperfect information regarding the value of the stock of genetic resources (and thus, on its benefits), we will have uncertainty about the optimal level of conservation. Perhaps more importantly for ABS is another source of uncertainty: that which may be present in private bioprospecting pay-offs. This latter source incorporates uncertainties regarding the timing and quantity of returns to bioprospecting, as well as the future demand for goods derived from it. The 'right' level of conservation, however, is a complex issue with ABS being just one source to achieve the desired level. The discussion in this section concerning both sources of uncertainty highlights some of the difficulties underlying the link between ABS and biodiversity conservation. While ABS may help with the goal of preserving biodiversity, it is just one of many factors affecting an uncertain level of desired conservation.

Amplifying the **first** source of uncertainty to ABS is our ignorance of ecosystem functioning with regard to such things as threshold effects, keystone ecosystems, and number of species. As a result, there is uncertainty regarding the long-run environmental impacts of actions taken today. Due to the persistence and universality of knowledge gaps and information problems, it may be optimal to apply a precautionary approach (World Bank, 1999, p. 14). This gives rise to the 'quasi-option' value of the stock of genetic resources (OECD, 1999, pp. 29f.). Conservation opens up the option of better-informed decision-making, because better information can be acquired in the future. For example, better information may be needed regarding comparative returns from alternative forms of land uses which are likely to affect genetic resources (World Bank, 1999, p. 103). Waiting (i.e. preserving today) leaves society with a set of choices for future decisions. By investing today in preservation, one acquires the right, but not the obligation to keep, deplete, or even drive to extinction, a given resource or species tomorrow, when better information becomes available. Investment in research is a means by which policy-makers can resolve uncertainty by acquiring the information necessary to understand what options are available.

Given imperfect knowledge, investments in conservation are likely to be either insufficient or more than is needed at the margin. Thus, cost-benefit analysis will have to be accompanied by other resource priority-setting tools (OECD, 1996a; 1999b). Within a cost-benefit-analysis, expected benefits of an irreversible decision should be adjusted to reflect the loss of options it entails (Arrow and Fisher, 1974). If a project (e.g. an agricultural project requiring deforestation) leads to the loss of genetic resources, several options would be lost, and should be incorporated into the cost-benefit-scenario. Also, uncertainty about future preferences makes it impossible to correctly consider the interest of future generations. This type of uncertainty implies that decisions should have a bias towards conservation (Heal *et al*., 1996).

Note that, when investing in conservation of genetic resources, different projects may yield different returns or levels of conservation, depending on ecological, economic, and social conditions. This creates some uncertainty for the policy-maker in terms of where to spend scarce funds. For example, benefits gained from a conservation project will differ across geographic regions. It is likely that money invested in a *hot spot* region will yield higher benefits than money invested in a region that is either less rich in genetic resources and/or already well-funded. The kind of project involved is also important. A relevant question in this context is how many sustainability principles a particular project addresses (i.e. all of economic, social, and ecological sustainability, or only some of these?) Careful decision-making on how to spend money — available either from ABS or direct conservation contributions — is thus important.

The **second** level of uncertainty relates to the estimation of net present value of bioprospecting activities. While all industrial projects involve some degree of risk, R&D activities and conservation efforts engender much higher risks than others (World Bank, 1999, p. 103). In the case of pharmaceutical research, companies need to first calculate the probability of finding an active ingredient that produces responses from human physiology. They then need to find innovative applications that can be successfully marketed. If returns materialise, they will likely occur far beyond initial R&D efforts. This latter point is particularly problematic for small firms, who may not have the financial resources needed for such

long-term endeavours. In sum, bioprospecting investment typically involves long-term financial payouts and considerable risk assessment. Not surprisingly, investment with uncertain returns may require the promise of substantial returns before it is carried out. Most investors tend to be risk-averse and prefer to insure against risk[26] — or to spread risks by investing in a variety of different projects whose returns are negatively correlated to each other.

3.3 Transaction costs

Transaction costs include: the costs of gathering information; the costs of setting up mechanisms and institutions for evaluating and transmitting the information; and the costs of defining, monitoring, adjudicating and enforcing property rights, responsibilities, and liabilities (OECD, 1999a, p. 165). If transaction costs are high, they can function as a significant barrier to the conclusion of ABS contracts — especially in the case of heterogeneous and complex products. Even a marginal increase in the bureaucratic or financial barrier may lead some user institutions to terminate their bioprospecting-based research. In particular, research institutes such as universities and small enterprises (i.e. biotechnology enterprises) might not have the resources to begin a long and uncertain procedure. Onerous access restrictions may adversely affect non-commercial entities the most. Such an overall reduction of R&D in genetic resources would ultimately hurt provider countries, since income would be foregone.

Transaction costs can also have a direct negative impact on genetic resources, since reduced ABS may decrease incentives for conservation, and reduce ABS-based funds for conservation. Policy therefore needs to take into consideration the transaction costs linked to its implementation. The argument here is for clear and concise regulation, as well as for easy access to information about the ABS process and provider institutions. The ability of laboratories to synthesis or produce 'designer' drugs that are made to order has also recently been a popular alternative. For example, a number of popular drugs currently in widespread use were developed entirely in the laboratory (Ten Kate and Laird, 1999; Simpson and Sedjo, 1999). These activities are sensitive to relative prices — which are influenced by transaction costs such as access fees, royalties, etc. It has been observed that producing a commercial product by a semisynthetic process, i.e. a process using natural products as inputs, rather than a wholly synthetic one, is often cheaper than complete synthesis (Simpson and Sedjo, 1994, p. 37). High transaction costs could potentially tilt the advantage toward synthetic processes. To be clear, the transaction costs determined by both a country's ABS regulations and its institutional base are not as important relative to other provider countries as they are relative to alternative sources. Moreover, to the extent that these other sources cause technological advance, they may bring permanent changes in the relative price of bioprospecting.

3.4 Bargaining

Bargaining outcomes are also important determinants of relative shares of benefits received by each party involved in ABS. Bargaining problems may be as important an obstacle to efficiency as 'missing' (or not well-enforced) property rights. Several bargaining problems have been discussed in previous OECD publications (OECD, 1999b, pp. 16/22ff.), and are only briefly reviewed here. First, bioprospecting is characterised by unequal numbers of the two main parties — providers and users. In general, many parties are potential suppliers of genetic resources. Their large number contrasts to the few parties willing to invest in access to genetic resources. Currently, the number of parties interested in ABS and skilled enough to undertake bioprospecting is limited. This is notably the case in the pharmaceutical industry, where the 10 largest firms held 36 per cent of market share in 1995. Since even fewer companies would be qualified to

26. Note that some environmental risks are not necessarily insurable (Pearce, 2001).

undertake bioprospecting, the potential market is small, potentially giving a bargaining advantage to users (Simpson and Sedjo, 1994, p. 41).[27]

Second, bargaining power favouring industries may be caused by traditions in international law; that is, protection of intellectual property but a lack of legal protection for traditional knowledge concerning genetic resources. Currently available standards of intellectual property (such as patents, certification and collective marks, geographical indications, etc.) may ensure protection of some elements of traditional knowledge. However, elements of currently existing intellectual law (novelty, originality, inventive step, etc.) are considered to be limitations in the application of intellectual property laws and procedures to the protection of traditional knowledge. Therefore, the value of indigenous peoples' information may not be sufficiently codified, accepted, or protected in international legal frameworks. Without a special legal framework, there is no recourse when the information is used to create products. Thus, bargaining power — and, by implication, the potential to patent commercial products — may be influenced by intellectual property-rights schemes and their historical legal development (World Bank, 1999, p. 34).

Third, private information can create bargaining advantages for its holder. The main conclusion of non-cooperative models of bargaining is that bargaining is typically inefficient when each player knows something important that the other side does not know, such as the payoff from a successful agreement. As a consequence, negotiations may be protracted, costly, or unsuccessful (not all mutually beneficial contracts are actually signed).

Bargaining power is also dependent on bargaining-relevant attributes such as knowledge of markets, access to information, the possibility to hire lawyers and accountants, access to legal protection and enforcement, and the bargaining skill of a professional negotiator (OECD, 1997b, pp. 12f). These bargaining-relevant attributes may favour the side that is less financially constrained (i.e. able to borrow against future rents). In general, capacity building and information dissemination can help diminish differences in bargaining-relevant attributes between providers and users.

4. Issues in the implementation of ABS

The preceding sections outlined a conceptual framework for thinking about ABS, and explored some issues that impact its economics. In this section, the discussion moves away from the framework and begins to consider broader issues relevant to policy development for ABS. The Annex to this document provides some empirical findings from case studies that relate to the topics of this section.

4.1 Genetic resources — public property or public interest?

National ABS legislation translates national sovereignty over genetic resources into either public property or public interest.[28] When genetic resources are defined as the property of the state, the potential exists for implicit expropriation of private property (a 'taking'). In some countries, many rights are implicitly given with real estate contracts; in others these rights are retained by the government. For example, in some countries mineral rights are always retained by the state, and can be granted to any

27. Royalties in some contracts have been reported as low as 0.2 per cent (Vogel, 1996), although it is not clear that this reflects bargaining power or lack of scarcity. At that level, the financial benefits generated from bioprospecting may be insufficient to ensure it conservation.

28. In this paper, the terms 'state property' and 'public property' (and state interest and public interest) are used interchangeably – although there may exist differences between them concerning the scope and the legal statute, depending on national legal frameworks.

interested party, irrespective of who 'owns' the associated land. Changes in these rights, of course, may generate changes in the value of the property. With respect to genetic resources, the state's treatment of who legally owns the resources is crucial to the distribution of benefits. Whether the state recognises the right of the property owner will determine its obligations for compensation to individuals whose land may be the source of important discoveries.

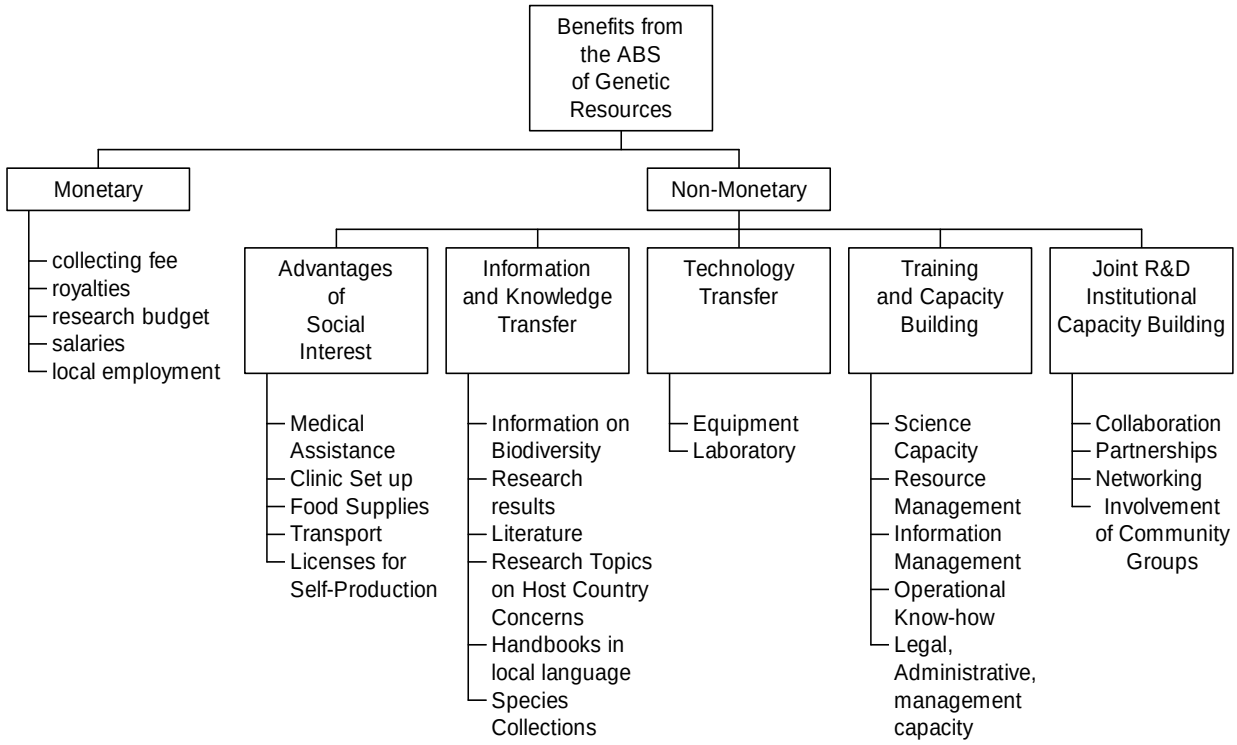
An alternative option is to consider its biological diversity a matter of state interest. In this case, genetic resources remain in the sphere of landowners' rights, but the right to use the land is limited by the state. This is the same kind of limitation that prohibits a person from destroying the environment situated on his/her lands. In this case, landowners can negotiate uses of their genetic resources, but the state must approve the final agreement. Certainly, the state can stipulate some obligatory clauses, or create fees or rules for benefit sharing with third parties. However, if these resources belong to the landowner inherently, they will have more power to bargain in the ABS contract.

At the moment, evidence suggests that countries have not clearly decided in favour of one approach or the other. We can even find both definitions operating within a single country's national legislation (e.g. Brazil, with its different treatments between state institutions).

4.2 The sharing of benefits

The sharing of benefits is one objective of the CBD (Article 8j and 15(7)). Both monetary and non-monetary benefits can be shared in various ways (Figure 2). Some examples of monetary benefits are: direct payment at the beginning of the contract; continuous payments during and after the collection of genetic resources or research activities; payment of a fixed amount in different stages of a drug's development, royalties, etc. Monetary benefits in the form of royalties can be a stream of payments of unlimited duration, or they may be restricted to fixed time periods — including the time span of a patent. There is, of course, wide latitude in arranging payment schemes. *A priori* payments help to limit distrust, while proportional payments are more flexible and can provide incentives. Contract partners can agree to variable payment in function of quality, product, value, and sales. Non-monetary benefits from bioprospecting can also play an important role (OECD, 1999b). Non-monetary benefits include: co-operative scientific research and technological development; capacity building; information exchange; consolidation of scientific research infrastructure; partnership in the economic exploitation of processes and products derived from genetic resources; and joint ventures for the creation of technological foundations. They may also include sharing intellectual property, and free licensing for the utilisation of patented processes and products. Thus, benefit sharing is often linked with capacity building, technology sharing, trade, and IPRs (OECD, 1999b, p. 8).

Figure 3. Possible benefits arising from ABS agreements



Source: OECD, 1997b, with minor modifications.

Royalty schemes have been a major element of most benefit sharing arrangements to date.[29] Royalties feature the provision of incentives, and are a risk-sharing measure. However, royalty schemes are not problem-free. For example, royalties calculated on the basis of profits run into the problem of private information (i.e. asymmetries between users and suppliers). The definition of 'profit' would have to be made very precise so that costs and revenues for a particular product could be isolated within a firm. This can be particularly difficult when firms have a portfolio of products they have developed on the *expectation* that the overall portfolio would achieve a certain profit level. Addressing this issue by basing royalties on production or revenues may help alleviate the information problem, but it raises some additional issues with respect to ensuring minimum levels of profitability for the firm.[30] For example, royalties are widely used in many technology-intensive industries. When they are based on production, for example in the manufacture of pre-recorded Compact Discs, they are treated simply as a fixed cost of production and projections of profitability account for that cost. Likewise, royalties paid to sources of genetic resources will become part of the calculation of the expected return to product or product-line development. The level at which a royalty is set will therefore have important implications for firm decisions at very early stages of investment.

29. The Bonn ABS Guidelines include the suggestion that near-, medium-, and long-term benefits should be considered, and that mutually-agreed terms could cover the conditions, obligations, procedures, types, timing, distribution and mechanisms of the benefits to be shared.

30. The Suriname ICBG program dealt with this. In determining royalty rates, consideration was given to the type of patent claims granted, potential product sales, the level of development and potential costs of subsequent research and development, marketing exclusivity to a private firm, the competitive impact of related marketed products, the degree to which the patents in question are dominated by the firm's patents, the necessity of paying royalties to third parties having dominant rights, and the extent of contributions of ethnobotanical knowledge or uses.

A final issue concerns genetic resources present in more than one country. Will eligibility for benefits from bioprospecting be restricted to the region where bioprospecting was carried out, or all registered habitats (or even knowledge holders) for a particular genetic resource (or types of information)? One possibility is for revenues to be distributed among countries that *could* have provided the same genetic resource — sharing might be based, for example, on their share of habitat for the species being bioprospected. However, not only does this create a significant need for information, it may also be in conflict with the economic rationale of benefit sharing — which was identified as granting access to the genetic resources in question. The incentive for putting in place rigorous ABS frameworks would be weaker if a country knew that it would have to share revenues with a passive partner. This issue — which is of particular relevance in the agricultural domain — has been partially addressed in the context of the International Treaty for Plant Genetic Resources for Food and Agriculture adopted in 2001, through its Multilateral System of Facilitated Access and Benefit Sharing. Recognizing both the physical non-excludability of many of these genetic resource, and the need for maintaining non exclusive access to the genetic variability (as provided for under the International Union for the Protection of New Varieties of Plants (UPOV) plant breeders' rights system) the Treaty provides facilitated non-exclusive access to the genetic resources under its scope, and creates a multilateral procedure for benefit-sharing, disconnected from individual transactions of genetic resources.

4.3 Contracting

Negotiating and implementing contracts for ABS is an important goal of establishing frameworks for ABS agreements. Contracts, however, can only be negotiated when each party is fully cognizant of its own interests in negotiation and has a good appreciation of the limits of markets to address their concerns — there must exist a range of outcomes that are beneficial to both buyer and seller. The preceding sections attempted to lay out the relevant factors that would affect the distribution of benefits accruing to both suppliers and users of genetic resources. Writing a contract for ABS is the formalisation of the process of valuing those factors. Bargaining resolves their relative valuations and determines the allocation of benefits (asymmetry of information can be a crucial factor in the outcome of bargaining).

A primary motive for contracts is the reduction and/or sharing of risk. For example, companies and research institutions interested in bioprospecting are concerned primarily with ensuring availability of genetic material in desired quantities and qualities. A secure flow of genetic material may be needed for R&D when sequential testing is necessary. More importantly, as that testing and development proceeds, each stage requires more material than at previous stages (Simpson and Sedjo, 1994). Contracts can address this problem, by giving assurance of the long-term availability of supplies. They do so by providing incentives for investing in trained and well-motivated ground staff. They may also provide incentives for conservation when they create a stream of payments contingent on availability (e.g. royalties (Simpson and Sedjo, 1994, pp. 38f)).

Payment structures that are subject to commercial success (such as royalty payment schemes) are means to share risks associated with investing in bioprospecting. However, it is difficult and costly to monitor the complex processes lying behind R&D over several years.[31]

As outlined earlier, the contracting process and certain contract details may alleviate asymmetries of information. For example, this will happen when the provider is better informed than the user concerning

31. The average development time of new pharmaceutical products is about 12 years (Simpson/Sedjo, 1994, p. 38). As for the duration of R&D, pharmaceuticals, commercial agricultural seeds, and chemical pesticides for crop protection take approximately 8-15 years. Botanical medicine, transgenes, and the industrial enzyme industry need 2-5 years (Ten Kate, 1999).

the quality of the genetic resources. The user then will find it advantageous to incorporate incentives to reveal value, such as payment schemes. Alternatively, the user may be the one with the informational advantage. Informational advantages gained during research activities may be used to 'bargain down' the share received by the provider. Strong contracts are thus crucial for avoiding opportunistic behaviour on either side (Simpson and Sedjo, 1994).

Contracts can also be powerful public relations tools. Since companies are generally sensitive to public opinion, especially when they depend on a few products for their incomes, 'fair' ABS contracts can lead to positive media coverage. Favourable publicity can then translate into higher sales and increased profits.

Imperfect information in contracting for ABS can be ameliorated by disseminating information more widely — for example, by using institutions such as state agencies, private organisations, laws, or social norms (World Bank, 1999, p. 3). Information centres can play an important role in the elimination of information asymmetries, by decreasing transaction costs.[32] They can provide information to verify quality, find matching contract partners, and organise information on ABS, thereby making it easily accessible for those interested. Other mechanisms to alleviate information problems are certificates for training, performance reports, and the setting of common and rigorous standards, based either on direct public action or on private standards (World Bank, 1999, p. 11). However, poor countries often lack the institution of capacity needed to certify quality, enforce standards and performance, and gather and disseminate information needed for business transactions (World Bank, 1999, p. 1). An alternative that has received some attention at the conceptual level is a mediator who may, for example, create a scheme by which each party is provided an incentive to reveal its true private information about benefits and costs (e.g. Farrell, 1987).

On a broad level, ensuring diligence in carrying out a contract is a responsibility of the state, since it holds genetic resources under its sovereignty. There may, however, be other reasons for state involvement. Although stakeholder participation can benefit contract enforcement, local communities are unlikely to be able to monitor and enforce performance by themselves. They generally lack the financial resources and information management systems for controlling contracting partners. If a community feels an arrangement has been broken, it may neither be able to afford attorney fees nor to engage enterprises in foreign courts. State assistance in the enforcement of contractual clauses could be granted in many ways (e.g. providing information; empowering a public prosecutor). For example, draft guidelines proposed by Switzerland suggested a need for a 'competent national authority' to help communities realise the benefits of the contract and solve possible problems, as well as to assist them in solving differences arising between stakeholders — this eventually became sub-paragraph 16.a(7) of the Bonn Guidelines . Paragraph 16 also addresses the issues of roles and responsibilities of users and providers.

The experience with the limited instances of access agreements that have been implemented thus far suggests that non-compliance is not a significant problem. Researchers appear to be honouring their obligations under their access agreements. Accordingly, in the short-term, countries would be better off focusing limited resources on building institutional and human capacity to develop and implement workable ABS regimes and conclude mutually beneficial access agreements — without undermining the important goal of establishing ABS systems with incentive-compatible rules and guidelines that lead the market to socially desirable outcomes. For the long-term, however, control of contract implementation may be necessary in circumstances where incentives for non-compliance become evident. This would include compliance with ABS legislation as well as with ABS contracts.

32. One example is the CBD Clearing-House Mechanism. The Clearing-House Mechanism was set up according to CBD Article 18 (3) in order to promote and facilitate technical and scientific co-operation (See OECD, 1997b, p. 10).

Finally, contracting may also provide a means to address some difficult (but potentially important) issues in ABS. Throughout this study, a focus has been placed mainly on commercial uses of genetic resources. However, bioprospecting is also of interest to non-commercial researchers — 'non-commercial research' has been a major element in many previous discussions of ABS of genetic resources. An important question is how to include into the ABS agenda research institutions, such as universities, who may do basic research from public funding. The lack of prospective revenues may hinder their ability to pay fees or make up-front payments of any kind. Nonetheless, it is not uncommon for researchers (and sometimes even their institutions) to patent information, and then to develop commercial enterprises based on those patents. One way to deal with this would be through the contracting of benefit sharing, for example, in the form of information exchange and capacity-building. Other alternatives also exist which might include a general agreement (contract) that if patentable products were later found, the royalty agreement could be re-negotiated. If the researchers had a good general sense of the types of final products they were attempting to develop, then a royalty agreement could be specified to be contingent on commercial success. Given the historical importance of non-commercial research undertaken for the 'public good', it is important that this objective be included in any future ABS framework.

4.4 Participation of local stakeholders

CBD rules concerning prior informed consent, benefit sharing, and other aspects refer predominantly to states. Article 8(j), however, puts the emphasis on respecting the needs of indigenous and local communities. This somewhat contradictory stance is reconciled by 'calling' on countries to recognise local interests. For example, the Bonn Guidelines, under paragraph 26 (d), includes as a basic principle of prior informed consent, the following: 'Consent of the relevant competent national authority (ies) in the provider country. The consent of relevant stakeholders, such as indigenous and local communities, as appropriate to the circumstances and subject to national law, should also be obtained.' Consistent with this spirit, laws in some countries have been implemented respecting the right of indigenous communities to refuse access to genetic resources within their lands and/or access to traditional knowledge (e.g. Brazil, Costa Rica, etc.). However, such rights can sometimes be over-ruled, if access to genetic resources is considered relevant to the public interest.

Most ABS laws enacted thus far mention the participation of local groups, but leave the determination of how the benefits should be managed and divided for a national committee to decide on a case-by-case basis. Some laws, however, predetermine the percentage of benefits going to locals. An example is the initiative of the Organisation of African Unity (OAU), which states that 50 per cent of all benefits must be designated to local communities and indigenous peoples. Several examples are provided in Annex II, such as the Africa ICBG, the Latin America ICBG, the Suriname ICBG and the TBGRI-Kani case in India. Since it is local groups who often bear much of the cost to conserve genetic resources, the goal of building and maintaining coalitions in favour of conservation would lead to the conclusion that they should be compensated for participating in the process. When local users and landowners receive benefits from ABS, they have a strong incentive to continue sustainable use (e.g. Swanson, 1993).

Involvement of landowners and local community interests is also important because incentives for conservation need to be directed to those who decide on land use. If sufficient returns from information contained in genetic resources do not reach those who decide on land-use patterns, they may have no incentive to invest in biodiversity, and will instead prefer alternative land uses with higher pay-offs (OECD, 1999b, pp. 13ff.). For example, landowners are routinely faced with the decision between sustainably managing their land with access agreements, versus more extractive land uses. If compensation is higher (and also more direct) for those alternative land uses, it is economically rational for them to decide in favour of the alternative that produces the higher net income. The same is true for local communities.

4.5 Earmarking of benefits

The question of earmarking is also relevant as part of the broad discussion concerning the management of resources relating to ABS. While there is little expectation that large sums of money will flow from access agreements, it is nonetheless, prudent to discuss the uses of those limited funds — indeed, a thorough discussion may be even more necessary if the income from ABS is small relative to the needs of biodiversity conservation. The question is one of the circumstances under which outcomes are improved when some part of the monetary benefits from ABS flow into the general budget versus being earmarked in favour of conservation objectives. Earmarking of public revenues is intended to ensure that future budget decisions are restricted from these revenues, so that short-term needs will not determine long-term outcomes.

Of course governments are under constant pressure to justify expenditures on various programs and leaving biodiversity outlays within the general budget would ensure that the trade-off with other programmes is made at the right level. In countries with advanced public-finance systems, where programme review occurs regularly, there would be no need for earmarking. To the extent that governments account for the non-marketed facets of biodiversity, this argument against earmarking is compelling and has been advocated by the OECD as a general proposition. In other cases, however, such as in many non-OECD countries, the equating of social benefits across programmes is unlikely to be achieved since the government apparatus to reach it may be inadequate. In that case, earmarking can be a means of attempting to ensure that, at the margins, the social benefits from biodiversity are roughly equal to the expenditure from the earmarked funds.

One drawback of earmarking is that it can encourage economically wasteful rent-seeking behaviour by interest groups who will vie for the earmarked funds. While this may not be a large problem in an ABS context because the amount of earmarked funds are not likely to be large, it still poses a potential difficulty. This is because lobbying for the earmarked funds will always occur to the point where the cost is equal to the potential gain. The basic problem of rent-seeking is that resources are devoted to increasing the chances of self-interested agents being on the receiving side of transfers. In a biodiversity context this may mean that projects are suggested which have benefits that are predominantly in areas only marginally related to biodiversity. This rent-seeking is rational from the individual's perspective, but causes the dissipation of resources in the pursuit of zero-sum transfers, and therefore subtracts from national wealth (Wyrick and Arnold, 1989).

From a theoretical perspective, earmarking can act as a partial commitment mechanism to solve time inconsistency problems of environmental policy (Marsiliani and Renström, 2000). Although being optimal at the outset, a government policy is dynamically inconsistent when it is no longer optimal at a later date — even without new information. Earmarking provides some reassurance that the policy commitment is durable, and that long-term investments may be made with confidence. This underpins observation made above that more generous terms can be negotiated in ABS agreements if there is some certainty regarding the expenditure of the funds.

Analysis suggests that demand elasticity with respect to income will determine whether earmarking is able to secure higher expenditures than general budgeting will. More elastic demand (found, for example, with environmental protection, and thus with biodiversity conservation), was perceived to lead to a lower willingness to pay when income decreases. Therefore, public spending in cases of elastic demand is higher without earmarking (Buchanan, 1963). Funding for biodiversity conservation may thus be greater when advocates focus on a larger general budget ratio for the environment.

This argument can be strengthened by a rather practical political problem. Earmarking for a certain public service often leads political decision-makers to only assign earmarked revenues to the conservation

of biodiversity. That is, earmarking can serve as an argument against providing additional financial resources from the general budget for such purposes already covered by earmarking. While earmarking ensures that some resources will be assigned to the desired objective, those resources might be insufficient for implementing a given program.

4.6 Capacity-building and institution-building

The building of intellectual, informative, productive, institutional, administrative and legal capacity in developing countries — the predominant providers of genetic resources — is necessary in order to ensure efficient and fair ABS agreements (contractual and otherwise). Capacity-and institution-building is not only a distributive issue, but may also imply efficiency gains through co-operative behaviour (OECD, 1997b, pp. 12f.; OECD, 1999b, p. 23/26). Examples include standardised access legislation and internationally agreed procedures for prior informed consent, among others. Decision VI/24B of the CBD COP included draft elements of an Action Plan on Capacity-building for ABS and put in place an Open-ended Expert Workshop on Capacity-Building for Access and Benefit-Sharing. Some of the key areas discussed in the draft elements include developing human capital and information systems for the formulation of ABS frameworks, as well as building scientific capacity to support and monitor ABS-induced activity.

Building up local capacity in R&D is a form of *vertical integration*, and can provide an alternative to contracting. It is aimed at undertaking a greater sharing of activities (and thus costs) of product development, so as to capture a greater share of the *value added* within the provider country (e.g. via joint research (Reid *et al*., 1993; OECD, 1997b, p. 25)). However, only tasks that give the provider country a comparative advantage or control over scarce resources may result in the capturing of rents. Advantages for uses of building capacity in provider countries may be found in achieving adequate collection, with quality of local samples, and local expertise concerning traditional uses and ecological information. Capacity-building includes preparing a labour force to ensure adequate recording of sample collection, such as location, ecological conditions, and additional details. Vertical integration requires investment in specialised equipment and expertise, as well as the acceptance of greater risks. The attractiveness of such investment depends on the ABS offers and transaction costs in coming to terms with provider institutions.

An important reason for substantial investments in capacity-building is the creation of comparative advantage. Information pre-processing centres can be established in provider countries, possibly using private capital (Chichilnisky and Heal, 1998). Such centres would conduct preliminary analysis and sell the right to use the results of that analysis — generating royalties for the providers of genetic resources. Provider countries which pre-screen their genetic resources (and thus gain more information about their value) may also be able to procure better deals from users when they eventually reveal this information.

5. Conclusion

This study develops an economic framework for examining issues related to the access and benefit sharing (ABS) of genetic resources. The analysis is aimed at providing policy-makers with an understanding of economic problems arising out of ABS of genetic resources. A distinction is made between biological resources, genetic resources, and traditional knowledge. All three are of potential interest to users of genetic resources. Yet, they each exhibit different economic characteristics concerning excludability and rivalry in consumption. *Genetic resources* exhibit open-access characteristics. Even with the CBD and national legislation acknowledging the sovereign right of nations over their genetic resources, excludability of genetic resources may be difficult to enforce. In some circumstances this may also be true of biological resources. Genetic resources are non-excludable because genetic *information* is inherently

non-excludable. However, genetic information exhibits a second level of excludability, since only entities with sufficient know-how, technology, and financial resources are able to extract this information. Among these entities, such information remains non-excludable, unless adequate protection, (e.g. IPR regimes) is put in place. The third asset, *traditional knowledge*, is clearly excludable, since it is commonly held by individuals. Concerning rivalry in consumption, both genetic resource and traditional knowledge are non-rival, but biological resources are rival in consumption.

The analysis allows for two main conclusions. First, it is important for ABS policy and legislation to account for the different economic characteristics of these three assets — each will require a different type of policy response. This applies as well to permitting a distinctive treatment for specific ABS project characteristics, such as whether the bioprospecting purpose is of a commercial or non-commercial nature. Second, transaction costs, bargaining context, etc., within the domain of ABS legislation are significant factors in the success of ABS policy. Transition costs will impact the institutional framework in ways that can either support or undermine ABS objectives. If obstacles to access to genetic resources are too high, those interested in ABS may find that their best interests involving opting out of the process of conserving or sustainably using these resources. Third, in the implementation of ABS legislation, there are a number of issues that can be addressed. While not central to the viability of ABS, each of these issues can impact on the benefits to users and providers. These include: how benefits are shared, capacity-building endeavours, contracting, etc. Explicit consideration of these other issues in policy development could help ensure that countries achieve maximum benefit from ABS.

The paper leaves unanswered a number of questions related to ABS and relevant to incentive design and policy-making unanswered. For example, while it summarizes the economic rationale of benefit sharing for providers and users, it does not analyse different contractual arrangements or the incentives embedded in them. Moreover, while discussing the concept of monetary and other types of benefits, and providing examples of application, the paper does not focus on specific instruments. Both areas deserve additional attention. This would require gathering information not readily available, such as actual contracts, and product related information (marketing strategy, typical revenue streams, etc.). It would likely benefit from drawing comparisons with other sectors, such as petroleum, mining, and other industries with important IPR issues. Learning how these sectors establish contractual arrangements in benefit sharing may shed light on genetic resources as well. Another potential question is whether states could define their sovereignty right over their natural resources differently for different purposes (e.g. for ABS of genetic resources versus forest concessions). Such distinct definitions of property rights may or may not cause problems and therefore could be developed further. A final consideration for further research is the idea that ABS might not have to be restricted to genetic resources. For example, permission to access an area for hunting purposes often requires a hunting permit. The idea of such permits could be subsumed into access and benefit sharing of biological resources.

A brief comment on the use of revenues derived from ABS is also in order. Unless government policy internalises the public values of biodiversity, returns to genetic resources paid by industries and other user institutions will only include private values. These will not cover those aspects of biodiversity that cannot be privatised — such as natural heritage, national treasures, scenic beauty, or global environmental benefits. Given the limited value of raw genetic resources from natural sources that is currently evident in the market, ABS benefits are in most cases unlikely to provide sufficient incentives for those who make decisions on land-use to favour conservation of natural habitat (and thus biodiversity). Incentives need to include not only returns on commercially-valuable characteristics of genetic resources, but also returns on those services which biodiversity-rich ecosystems render to wider communities (OECD, 100b, pp. 13ff.). To conserve biodiversity, additional strategies beyond ABS must therefore be utilised (Simpson and Sedjo, 1996). ABS legislation is only one component of the policies that are needed and (sometimes) undertaken for managing genetic and biological diversity. This also means that, in order to maximise the private and public value of biodiversity, incremental financing (i.e. above bioprospecting values) is necessary for

achieving the global benefits of biodiversity (OECD, 1999b, pp. 26 f.). However, values generated by bioprospecting and other market transactions will, in some cases, lessen the burden on public funds (Simpson and Sedjo, 1994).

While this study focuses on commercial uses of genetic resources, bioprospecting is also of interest to non-commercial researchers. In the past, such 'non-commercial research' has been a major factor in ABS of genetic resources. An important question is how to include ABS into the agenda OF research institutions, including universities. The lack of prospective revenues may hinder their ability to pay royalties. Nonetheless, researchers (and sometimes even the institutions themselves) patent information and then develop commercial enterprises. One way to deal with this is through benefit sharing, for example in the form of information exchange and capacity-building. Given the historical importance of non-commercial research undertaken for the 'public good', it is imperative that this objective be included in any future ABS framework. This may require some of the players to take a longer term view. Clearly, ABS contracting needs to be flexible enough to allow access for both those who are well-funded, as well as those who are not.

Finally, with the foundations established in the foregoing discussion, a more complete discussion is possible of applied issues in ABS. Some of the next areas which clearly deserve attention include adding value to the discussion on ABS by dealing, with: transaction costs that ABS frameworks create for users of genetic resources; the empirical results of the extant national legislation regimes (which may act as *de facto* bans on access); calculating the value to a country from the scientific information gained (the vast majority of research and collection of genetic resources is non-commercial and scientific, including taxonomic, which is vital to conserving the environment). Further, there is a need to look at which terms in contracts have worked well, and which have not. This would be an empirical exercise that would preclude a synthesis of what has already been learned. Other next steps could even include looking at where indigenous and local communities have been successfully brought in (e.g. the San people in South Africa and the people of Samoa), as well as where they have not (such as the Andean Pact, Brazil and the Philippines).

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ANNEX: FINDINGS OF CASE STUDIES

Some countries have already established national laws, including regional approaches, which regulate access to genetic resources, such as the Philippines, Costa Rica, Brazil, and Decision 391 reached by the Andean Pact countries (Bolivia, Columbia, Ecuador, Peru, and Venezuela). Others are in the process of developing their own national legal initiatives. Each legal instrument has a similar but somewhat different approach regarding ABS. Recently, several international frameworks in relation to Access and Benefit Sharing (ABS) have been put in place. For example, in April 2002, the Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization (Bonn ABS Guidelines) were adopted. In November 2001, the International Treaty on Plant Genetic Resources for Food and Agriculture was approved by the Conference of the United Nations (UN) Food and Agriculture Organization (FAO).

In this Annex, selected cases for which detailed information, such as contracts and detailed documents, are studied for factors causing differences between cases and the relation between the scope of benefits and the role of stakeholders. Comparing several cases, an attempt is made to find not only common characteristics but also differences from the viewpoint of establishing appropriate ABS regimes.

A.1 Special features of cases

A.1.1 An overview of the cases

A limited number of cases with regard to benefit sharing are available because in most projects benefit sharing contracts are confidential between stakeholders. However, fifteen case studies have already been submitted to the CBD Secretary (CBD, 1998). Among these, eight cases provided information detailed enough for the purpose of this study. In addition, there were several studies not submitted which were also available for this study: the Latin America ICBG (International Cooperative Biodiversity Groups) program[33], the INBio-Merck case[34] and three BRCP (Bilateral Research Cooperation Projects on the Conservation and Sustainable Use of Biodiversity) [35] cases. In total, thirteen cases were chosen to be used in this study (see Table A.1).

33. ICBG programs were organised by the USA government. Funding for these programs was provided by several different institutes: the National Institutes of Health (NIH), including the National Cancer Institute (NCI), National Institute of Allergy and Infectious Diseases (NIAID), and Fogarty International Center (FIC); the National Institute of Mental Health (NIMH), which subsequently became part of the NIH; the National Science Foundation (NSF), and the U.S. Agency for International Development (USAID).

34. A collaboration agreement was contracted between the Instituto Nacional de Biodiversidad (INBio), which is a Costa Rican scientific research institute, and Merck & Co., Inc. in the USA.

35. The BRCP between Japan and Thailand, Indonesia and Malaysia were conducted from 1993 to 1999. These projects were conducted by the New Energy and Industrial Technology Development Organisation (NEDO) in Japan.

Table A.1. Outline of cases

Cases	Related countries		The purpose of usage of genetic resources	Project aims	Target genetic resources
	Provider countries	User countries			
Africa ICBG	Nigeria and Cameroon	USA	Drug development	Integrated project	Plant
Suriname ICBG	Suriname	USA	Drug development	Integrated project	Plant
Latin America ICBG	Argentina, Chile, Mexico	USA	Drug development	Integrated project	Plant and Microorganism
Fiji	Fiji	UK	Drug development	Bioprospecting for Commercialisation	Marine and terrestrial organisms
INBio-Merck	Costa Rica	USA	Drug development	Bioprospecting for Commercialisation	Plant, insect and environmental samples
Ancistrocladus Korupensis	Cameroon	USA	Drug development	Bioprospecting	Plant
Calanolide	Malaysia	USA	Drug development	Product development for commercialisation	Plant
BRCP (Thailand)	Thailand	Japan	Screening of new bioactive substances	Integrated project	Plant and Microorganism
BRCP (Indonesia)	Indonesia	Japan		Integrated project	Plant and Microorganism
BRCP (Malaysia)	Malaysia	Japan		Integrated project	Plant and Microorganism
UC Davis	USA (originated in Mali),	USA	Agricultural use	Product development for commercialisation	Plant genetic resources for food and agriculture
TBGRI-Kani	India		Drug development	Product development for commercialisation	Plant
Yellowstone-Diversa	USA		Biotechnological application	Bioprospecting for Commercialisation	Microorganisms etc.

A.1.2 Several types of cases

Studied cases cover a broad range of benefit sharing schemes. Each of these cases is based on different situations and backgrounds. Several criteria were used to divide cases, such as countries involved, providers and users, project aims, the purpose of the usage of genetic resources, and the time of contracts. In this section, we provide brief descriptions of the types of cases involved.

Countries involved (both provider and user)

There were generally two types of situations. One is a user country, usually a developed country, and a provider country, typically belonging to developing countries. The other is a domestic project, with both the provider and the user coming from the same country. This situation is possible in both developing and developed countries. The TBGRI-Kani case and the Yellowstone-Diversa case are domestic benefit sharing cases, in India and the USA respectively.

As for the user countries involved, most of the cases come from U.S. organisations, three come from Japan and one from India. Three ICBG cases are from the same program, but the actors in each of these are different, except for the ICBG funding organisations. The user in the Fiji case is a UK organisation, but this organisation acts as a broker[36]. On the other hand, there is a variety of provider countries from African

36. The project fund was supported by a consortium of the World Wildlife Fund (WWF), the Nature Conservancy, and the World Resources Institute (WRI) funded by USAID.

countries, Central and Latin American countries, Southeast Asian countries, India, and the USA. These countries, among others, are commonly recognised as genetically rich countries.

Country variety should be considered an important factor because Intellectual Property Rights (IPRs) systems and the policy or regulations to address ABS issues differ in each country. In most cases, each stakeholder, such as private firms, academic organisations, and local communities, as well as governmental organisations, complies with the rules of their respective countries. Undoubtedly, there are other cases from both developed and developing countries. Unfortunately, we did not have access to cases from other major countries in this study. In the next phase, we should collect and study more examples from both user and provider countries.

Project aims

We can divide the cases into two types regarding project aims. The aim of ICBG programs and BRCP cases are not only to screen for bioactive substances, but also to contribute to training of local scientists and finding ways to promote conservation and sustainable use of biodiversity. Hereinafter, these cases are called 'Integrated Projects'. In these projects, governments, including both provider and user, had an important role to play. Many actors are involved in each project on both sides. Also, the scope of benefits covered a wide variety.

The other type of cases, Non-Integrated Projects, pays more attention to bioprospecting or product development than other purposes. The Ancistrocladus Korupensis case, the Fiji case[37], the INBio-Merck case, and the Yellowstone-Diversa case mainly aimed at conducting bioprospecting activities. The rest of the cases, such as the Calanolide case, the UC Davis case, and the TBGRI-Kani case, pursued product development for commercialisation. In these projects the actors involved are more limited than in Integrated Projects. Also, the scope of benefits was in a narrow rage.

The purpose of the usage of genetic resources

Several industrial sectors have been collecting and researching genetic resources and developing new marketable products, such as drugs, botanical medicines, major crops, cut flowers and potted plants, as well as other biologically-active compounds for a variety of purposes. These sectors include agriculture, pharmaceuticals, horticulture, biotechnology, and others[38]. Most industrial sectors utilise genetic resources as both raw material and for the information inherent in them, according to their own interests.

The processes and costs of Research and Development (R&D) differ with regard to types of marketable products. According to a rough estimate (Ten Kate, 1999), both the duration and costs of R&D vary from one industrial sector to another. As for the duration of R&D, pharmaceuticals, commercial agricultural seeds, and chemical pesticides for crop protection take approximately from eight to fifteen years. On the other hand, botanical medicine, transgenes, and the industrial enzyme industry need from two to five years. As for the costs of R&D, pharmaceuticals, chemical pesticides, and the transgene industry

37. The aim of the Fiji case is to develop an equitable prospecting agreement, set up a procedure to collect and process samples and to develop biological and social monitoring systems as well as bioprospecting.

38. The annual global market for various categories of products derived from genetic resources was between USD 500 billion and USD 800 billion The biggest market was agricultural produce representing USD 300 billion to USD 450 billion. The second was pharmaceuticals ranging from USD 75 billion to USD 150billion. (ten Kate and Laird, 1999).

require a lot of money: from several tens of millions USD to several hundreds of millions USD. The other industrial sectors incur less R&D costs compared to the above-mentioned industrial sectors.

In this study, the purpose of collecting genetic resources, in most cases, is drug development. Two cases focused on agricultural product development and biotechnological applications. The main aim of BRCP projects is to find new bioactive substances for pharmaceutical, agricultural and other usage. The pharmaceutical industry is one of the most important players in ABS systems because of its enormous market size, the potential for technology transfer to local economies, and others. But there are also other important sectors using genetic resources. In the future, we should study more cases from a variety of sectors and pay attention to investigating similarities and differences in sectors.

The time of contracts

The time a contract is signed during the product development stage may be one of the main factors influencing ABS systems. Roughly, product development can be divided into four stages: collection of genetic resources[39], scientific research and development[40], product development, and commercialisation. Some projects were contracted at the collection of genetic resources stage; others made contracts in the latter stages of product development.

The ICBG programs, BRCP cases, INBio-Merck and Yellowstone-Diversa arranged contracts at the collection stage of bioprospecting activities. Local communities played more important roles than in the other cases because of their direct contributions to the collection activities, including on occasion, the use of their traditional knowledge (TK). On the other hand, the Calanolide case and the UC Davis case were contracted at the product development stage. TBGRI-Kani is a case between the TBGRI (Tropical Botanical Garden and Research Institute) and the licensee company at the commercialisation stage after the TBGRI had finished the development of a new drug.

A.2 Benefit sharing mechanisms

A.2.1 Stakeholders and their roles

Stakeholders

In each project, there are many types of stakeholders involved, such as governmental organisations, academic organisations, private firms and NGOs (Non-governmental Organisations), from both provider and user countries, and local communities in provider countries. We divided these actors into eight groups. As for the user country, governmental organisations, academic organisations, and private firms were included. On the provider, we distinguished between academic organisations, local communities, local companies, governmental organisations, and local NGOs (see Table A.2).

The ICBG (International Cooperative Biodiversity Groups) programs and BRCP (Bilateral Research Cooperation Projects on the Conservation and Sustainable Use of Biodiversity) cases have a variety of actors from both the user and the provider because they were organised by various governments. The

39. The collection of genetic resources stage includes, for example, the acquisition of materials for screening and random, ethnobotanical and taxonomic collection.

40. The scientific research and development stage includes, for example, extraction, primary screening, isolation and characterisation of pure, active constituents, advanced screening and identification of active agents.

actors involved in other studies are limited. As for INBio-Merck[41] and Yellowstone-Diversa, mainly two players, a user company and provider organisation, participated. In Yellowstone-Diversa and TBGRI-Kani cases, the main actors belong to the same nation because these cases are domestic.

Table A.2. Stakeholder Participation in Each Case

	Related parties	User country				Provider country				
		Governmental organisations	Academic organisations	Private firms	NGOs	Governmental organisations	Academic organisations	Local Communities	Local companies	Local NGOs
Bilateral cases	Africa ICBG [1]	ICBG programe / WRAIR	STRI	S. ph	Healing Forest Conservancy	ESFD / MEF	U. Dschang / U.Ibadan / Inter CEDD	N.U.M.H.P/ Umikabia U. / Owai C.		BDCP
	Suriname ICBG	ICBG programe	VPISU / MBG	B-MS		[2]		Saramaka Tribe	BGVS [3]	CI / STINASU
	Latein America ICBG	ICBG programe	UA / UP	AC			INTA / UNP / PUC/ UNAM	Loca residents		
	BRCP (Thailand)	NEDO	Several Universites	JBA [4]		NSTDA / RFD	TISTR / QBG / NCGEB	[5]		
	BRCP (Indonesia)	NEDO	Several Universites	JBA		BPPT	IPB / ITB / UGM / LIPI / UNPAD			
	BRCP (Malaysia)	NEDO	Several Universites	JBA		MOSTE / NBD	SIRIM /UM /USM /UKM /UPM /UNIMAS /FRIM /MARDI			
	Fuji			SIDR [6]	BCN	ProG / DeE	USP	Verata tribe		SPACHE
	INBio-Merck			Merk		MINAE [7]	INBio			E
	Ancistrocladus Korupensis	NCI	MBG			GoC / KNP	U.Y. / P.U.	Korup area		Korup Project [8]
	Calanolide	NCI	UIC	MR		GoS			SMP [9]	
Domestic cases	UC Davis		UC Davis / St. U. / IRRI	Agricultural companies			Mali [10]			
	Yellowstone-Diversa	YNP		Diversa	WFED					
	TBGRI-Kani					FoD	TBGRI / RRL	Kani tribe	AVP	

Notes:
1. There are more than 16 entities.
2. Not directly involved in this project.
3. Owned by the government.
4. The JBA is an association of bioindustry company in Japan.
5. Local communities involved in the project but did not act as important players in contracts.
6. Act as a broker.
7. There was a INBio-MINAE agreement regarding bioprospecting.
8. WWF Cameroon with KNP.
9. This is a joint venture between GOS and MR.
10. Original wild rice species were collected in Mali before the CBD adopted.

Generally, local governmental organisations, local academic organisations, user academic organisations and user private firms were major actors in most cases. Local communities, local companies, user governmental organisations and NGOs were sometimes involved in these cases depending on contract stipulations.

Local communities, including indigenous people and landowners, were generally recognised as desirable stakeholder participants in ABS systems. Local communities played a role not only as collectors of genetic resources and providers of TK (Traditional Knowledge), but also as conservers of biological resources in the Fiji case, the Ancistrocladus Korupensis case, and the TBGRI-Kani case, as well as ICBG

41. The Costa Rica government, the Ministry of Environment and Energy also involved in the ABS system because the INBio and the MINAE contracted and worked together on the national inventory.

programs. In the BRCP cases, local community participation was limited. Because these projects are conducted mainly as cooperative initiatives between two nations, and do not intend to directly develop commercial products. Thus, local communities were acted as collectors or providers of traditional knowledge but did not play a major part in contracts. Local companies, as well as local academic organisations, were expected to contribute to technology development in the country of origin because capacity building in developing commercial products may be one way to promote economic development in source countries. Local companies were involved in several cases such as the Suriname ICBG program, as a source government-owned company, and in the Calanolide case, as a joint venture between a user private firm and a local government.

The Role of each stakeholder

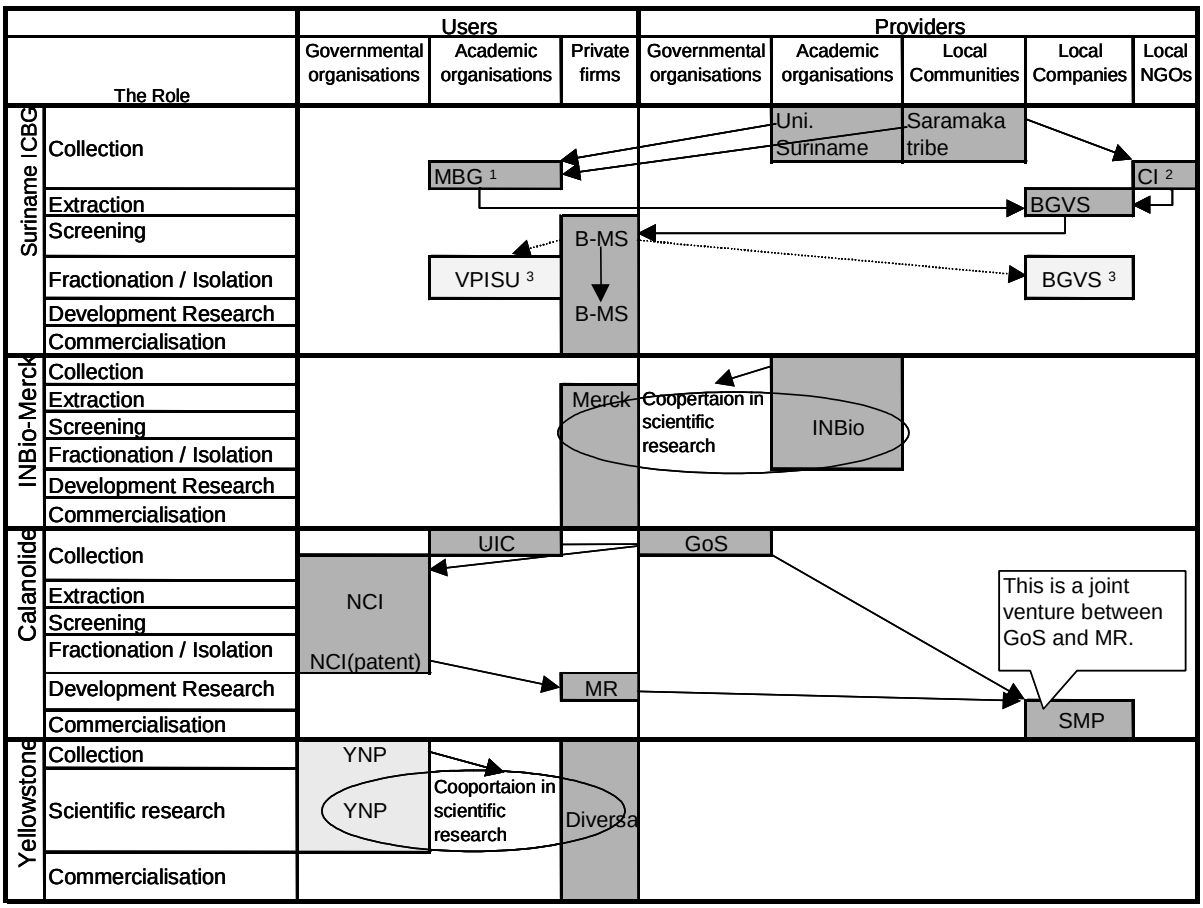
Stakeholder participation may depend on the aims of ABS arrangements widely diverse in type, according to their specific characteristics, such as related countries, project aims, the purpose of usage of genetic resources, and targeted genetic resources, among others. In other words, each stakeholder in a certain project has different requirements or roles to play, contributing to the project in its own way. Benefits should be decided so as to reflect the contributions from each stakeholder.

Table A.3 gives an overview of the relation between stakeholders and their roles in selected cases. Stakeholders are listed in the horizontal headings. Development phases are shown in the vertical headings of the table. The Suriname ICBG program is listed as an Integrated Project. The INBio-Merck case is an example of a Non-Integrated Project. In the Calanolide case commercialisation is conducted by a joint venture company established by the local government and a user private firm. The Yellowstone-Diversa is a biotechnological application example.

In the Suriname ICBG program, a local NGO, the Conservation International (CI), and an academic organisation of the user-country, the Missouri Botanical Gardens (MBG), are in charge of both random botanical collection and ethnobotanical collection. Even if the actual collectors are local communities, the Saramaka tribe, and the University of Suriname. After extraction at a local company, the Bedrijf Geneesmiddelen Voorziening Suriname (BGVS), a private firm of the user country, the Bristol-Myers Squibb Pharmaceutical Research Institute (B-MS), was obligated to test all samples for anti-cancer and anti-infective activity from the screening phase to future commercialisation. The INBio-Merck case is simpler because the main actors with regard to access to genetic resources are a local academic organisation, the Instituto Nacional de Biodiversidad (INBio), and a user private firm, Merck & Co., Inc. Collection was the responsibility of the INBio, and scientific research was conducted through a research cooperation scheme. The Yellowstone-Diversa case is similar to the INBio-Merck case. The Calanolide case differs from the first two: After isolating and patenting active Calanolide compounds by a U.S. governmental organisation, the National Cancer Institute (NCI), a licensee firm of the user country, the Medichem Research (MR), established a joint venture with the source country government.

The main role of local communities in product development was their collection activity and the provision of traditional knowledge, which is illustrated by the ICBG programs the Fiji case, and the TBGRI-Kani case. The scientific research and development stage was conducted by local academic organisations or local companies with support from the user, in the Africa ICBG, the BRCP cases, the INBio-Merck case and the TBGRI-Kani case, as well as the Suriname ICBG. User country firms, with participation from source country scientists, were the main actors in both product development and commercialisation, except for the Calanolide case, where a joint venture company was set-up between a user firm and the source country government.

Table A.3. The Role of Main Stakeholders in Selected Cases



Notes:
1. Random botanical collection
2. Collections using ethnobotanical knowledge.
3. Depend on each responsibility.

A.2.2 The scope of benefits

Type of benefits to be shared

Benefits, of course, are divided into two parts, monetary and non-monetary benefits. There is no official definition with respect to benefits generated from the use of genetic resources. However, the Bonn ABS Guidelines, the International Treaty of the FAO and others have shown the expected scope of benefits in their own provisions.

The Bonn ABS Guidelines includes the suggestion that near-term, medium-term and long-term benefits should be considered and that mutually agreed terms could cover the conditions, obligations, procedures, types, timing, distribution and mechanisms of benefits to be shared. It has also been suggested that royalties alone should not be relied upon. Equity, profit sharing and joint venture opportunities may also be offered by companies. And monetary benefits might include access fees, up-front payments, milestone payments, royalties, license fees in case of commercialisation, trust funds, salaries, research funding, joint ventures and joint ownership of relevant intellectual property rights. Non-monetary benefits might involve: sharing of research and development results, collaboration, cooperation and contribution in

scientific research and development programs, participation in product development, collaboration, cooperation and contribution in education and training, admittance to ex-situ facilities of genetic resources and to databases, transfer to the provider of the genetic resources of knowledge and technology, capacity building, access to scientific information, contributions to the local economy, food and livelihood security benefits, social recognition, joint ownership of relevant IPRs , and others.

The International Treaty also presents suggestive mechanisms to conduct benefit sharing, which was agreed upon by FAO Member countries. These mechanisms cover exchange of information, access to transfer of technology, capacity building, and the sharing of monetary and other benefits in case of commercialisation.

The Andean Pact Decision 391 and some national regulations set the scope of benefits according to their own interests. Other national regulations such as those of the Philippines and Costa Rica had regulatory provisions with no detailed description, dealing with it on a case-by-case basis.

Referring to these frameworks and regulations, we can divide benefits into several types in this study. Monetary benefits may be roughly divided into eight kinds: access fees, milestone payments, royalties, license fees in case of commercialisation, trust funds, salaries, research funding, and joint ventures. As to non-monetary benefits, the following mechanisms are conceivable: collaboration in scientific research and development, participation in product development, exchange of information, training, capacity-building, contributions to the local economy, and joint ownership of patents (see the vertical headings of Table A.4).

General tendencies of the scope of benefits

By applying this benefit sharing scheme to each case, we constructed Table A.4. It shows the scope of benefits for each case in which enough data was available to proceed with this study. In the horizontal headings you find several cases. The vertical headings represent benefits to be shared, including both monetary and non-monetary benefits, especially for providers. The six cases on the left side of the horizontal headings are Integrated Projects. Dark coloured cells indicate that this benefit was shared in a relevant case.

Firstly, taking a look at this table as a whole, in most cases, benefit sharing schemes involved payment of royalties, sharing of research and development results, collaboration in scientific research and development, collaboration in education and training, transfer of knowledge and technology, institutional and professional relationships. Research funding, joint ventures, and others might be, in some cases, recognised as one of the main benefit sharing items, depending on specific needs or conditions.

Secondly, from the point of view of project aims, Integrated Projects, such as ICBG programs and BRCP cases, cover a wide rage of benefits, especially with regard to non-monetary benefits. These cases involve many kinds of process benefits[42], capacity building and other benefits contributing directly or indirectly to the development of local communities, including training related to genetic resources conservation, scientific information about conservation and sustainable use, and contributions to the local economy. On the other hand, Non-Integrated Projects deal with a more focused scope of benefits. One point in common between the two types is that process benefits are considered as important items in a benefit sharing scheme.

42. Process benefits include such as sharing of research and development results, collaboration in scientific research and development programs, participation in products development and so on.

Table A.4. Role of main Stakeholders in Selected Cases

		Projects	Africa ICBG	Suriname ICBG	Latin America ICBG	BRCP Thailand	BRCP Indonesia	BRCP Malaysia	Fiji	INBio-Merck	Yellowstone-Diversa	Ancistrocladus korupensis	Calanolide
		The aim of project	1	1	1	1	1	1	2	2	2	2	3
Monetary Benefits		Access fees/fee per sample									4		
		Milestone payments											
		Payment of royalties											
		License fees								5			
		Trust funds											
		Salaries											
		Research funding											
		Joint ventures											
Non-monetary Benefits	Process benefits	Sharing of research and development results											
		Collaboration in scientific research and development programs											
		Participation in product development											
		Collaboration in education and training											
		Transfer of knowledge and technology											
	capacity-building	Capacity-building for technology transfer to user developing country, and of local and indigenous people to conserve and sustainably use their genetic resources											
		Institutional capacity-building											
		Capacity-building of human and material resources for the administration and enforcement of access regulation											
	Others	Other training related to genetic resources											
		Scientific information about conservation and sustainable use of biological diversity											
		Contributions to the local economy											
		Research, such as health and food security											
		Institutional and professional relationships that can arise from ABS schemes											
		Joint ownership of patents and other relevant forms of IPR.											

Notes:
1. The Integrated Projects.
2. Bioprospecting for Commercialisation.
3. Product development for commercialisation.
4. Yellowstone: Diversa provided YN Park with an up-front payment of USD 100 000 to be offset against any future royalty payments.
5. INBio:It is not sure that license will be involved in all royalties.

Unfortunately, from the viewpoint of country variety and the purpose of usage of genetic resources, the selected cases feature no major distinguishing characteristics because of the limited number and variety of cases available for this study.

Scope of benefits by stakeholder

In this section, our purpose is to find out, in general, which stakeholders, especially provider stakeholders received what kinds of benefits in ABS projects. After identifying the receiver of each benefit in each case, we did a simple calculation: we divided the number of examples receiving a certain benefit by the total number of cases. Thereby, we obtain 'the Benefit Distribution by category and stakeholder'[43].

43. For example, in the Africa ICBG program, 'collection fees' were paid to local communities. Accordingly, we identified who shared in each benefit in each case. Next, we paid attention to each benefit by type of stakeholder, such as access fees to local communities, payment of royalties to local governments. Then, we

Table A.5 represents this distribution. The results were divided into three types: All cases, Integrated Projects and Non-Integrated Projects. 'All cases' includes all cases in this study, that is to say, eleven cases. 'Integrated Projects' includes three ICBG programs and three BRCP cases, in total six cases. 'Non-Integrated Projects' include five cases

According to Table A.5, we can roughly understand who would usually receive or might not receive what kinds of benefits. On the horizontal headings, there are the three types 'All cases', 'Integrated projects' and 'Non-Integrated Projects'. Within each type, there are five stakeholder categories. Stakeholder categories '1' to '5' show local governmental organisations, local academic organisations, local communities, local companies and local NGOs, respectively. The vertical headings are the same as in Table A.4. We used three shades of colours for the cells, depending on the Benefit Distribution rate. The darkest colour shows that the Benefit Distribution rate is higher than 50 percent, that is to say, more than half of the total cases concerned shared this benefit with a certain stakeholder. The light dark colour shows that the Benefit Distribution rate is from 0 to less than 50 percent. For example, in 'All Cases', it is highly probable that local communities (Stakeholder '3') will receive payment of royalties, license fees and/or salaries as monetary benefits and process benefits, institutional and professional relationships, and joint ownership of patents as non-monetary benefits (a Benefit Distribution rate above 50 per cent). On the other hand, local communities are less likely to get milestone payments, research funding, and joint ventures.

As a whole, Integrated Projects, such as ICBG and BRCP cases, show features distinct from Non-Integrated Projects. As mentioned above, Integrated Projects dealt with ABS projects from a wider viewpoint, including not only, for example, screening bioactive substances but also contributing to training of local scientists and finding ways to promote conservation and the sustainable use of biodiversity. That is the principal reason Integrated Projects have a wider scope of benefits than other projects.

The role of each stakeholder influences the determination of the scope of benefits. Each stakeholder may have more than one role in a project, especially local communities and academic organisations. But this is only a tendency, so which benefits should be shared with each stakeholder should be decided according to the situation in each case.

Local governmental organisations (stakeholder '1') receive payment of royalties, and sharing of research and development results in most cases[44]. Local Academic organisations (stakeholder '2'), including universities and research institutes, share several benefits, which you can see as coloured cells. These include payment of royalties and license fees in case of commercialisation, employment related to research work, process benefits, 'Capacity-building for technology transfer to user developing country and of local and indigenous people to conserve and sustainably use their genetic resources', and others. In addition to these, 'Institutional capacity-building' and 'Scientific information about conservation and sustainable use of biological diversity' were frequently shared, especially in Integrated Projects with local academic organisations (Africa ICBG, Latin America ICBG and BRCPS). However, in Non-Integrated Projects, the scope of benefits focused more on process benefits than capacity-building, or others. Local academic organisations play a role as supporters of collection activities, executors of scientific research and development, and sometimes collaborators in product development and others. The scope of benefits that these organisations could expect was mainly provided through project progress, and was related to

summed up the total number of cases sharing a certain type of benefit, and the number of all cases. We did a simple calculation, dividing the number of examples of a certain benefit by the number of all cases. For example, local communities received access fees in two cases, the Africa ICBG and the Fiji case. Therefore, the Benefit Distribution rate was calculated to be 40 per cent because the number of all cases was five. Of course, if a certain stakeholder did not participate in a certain case, that stakeholder was not included in the total number of cases.

44. In Africa ICBG, INBio-Merck,Yellowstone-Diversa and Calanolide cases.

technology, information and training regarding conservation of biodiversity from the scientific point of view (for example, Fiji, INBio-Merck and Ancistrocladus Korupensis).

Table A.5. The Benefit Distribution by Category and Stakeholder

		Projects / Types of benefits	ALL cases					Integrated Projects					Non-Integrated Projects				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Monetary Benefits		Access fees/fee per sample	▒		▒					▒			▒		■		
		Milestone payments															
		Payment of royalties	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		License fees	▒	■	■	■	■	■	■	■	■	■	▒	■	■		■
		Trust funds			▒		▒			■		■					
		Salaries		■	■	■			■	■	■				■		
		Research funding	▒	▒									▒	▒			
		Joint ventures	▒			■							▒			■	
Non-monetary Benefits	Process benefits	Sharing of research and development results	■	■	■	■	■	■	■	■	■	■	▒	■	■	■	■
		Collaboration in scientific research and development programs	▒	■		■	▒		■		■	■	▒	■			
		Participation in product development		▒		■			▒					▒		■	
		Collaboration in education and training		■	■	■	▒		■	■	■			■	■	■	■
		Transfer of knowledge and technology	▒	■		■	▒	■	■		■		▒	■		■	■
	capacity-building	Capacity-building for technology transfer to user developing country, and of local and indigenous people to conserve and sustainably use their genetic resources		■	▒				■					▒	■		
		Institutional capacity-building	▒	▒			■	■	■			■					■
		Capacity-building of human and material resources for the administration and enforcement of access regulation	▒					▒				▒					
	Others	Other training related to genetic resources	▒	■	■		▒	▒	■	■		■	▒		■		
		Scientific information about conservation and sustainable use of biological diversity	▒	▒	▒			▒	■	▒							
		Contributions to the local economy			■		▒			■					■		■
		Research, such as health and food security	▒	▒	▒		▒	▒	▒	▒		■					
		Institutional and professional relationships that can arise from ABS schemes	▒	■		■	■	■	■		■	■	▒	■			
		Joint ownership of patents and other relevant forms of IPR.	▒	▒	■	■	■	▒	▒	■	■	■	▒	▒		■	

1	Local Governmental organisations
2	Local Academic organisations
3	Local Communities
4	Local companies
5	Local NGOs

■ :The number of examples divided by the number of total cases is more than 50%.
□ :The number of examples divided into the number of total cases is 0%.
▒ :The number of examples divide by the number of total cases is from 0%to 50%.

Local communities (stakeholder '3') usually received: one part of future monetary benefits, such as 'Payment of royalties', 'License fees in case of commercialisation' and 'Salaries for their collecting work or services'[45]. They also received support for biodiversity conservation, such as 'Training related to

45. In ICBGs, Fiji, Ancistrocladus Korupensis cases.

collection and genetic resources'[46] and 'Contributions to the local economy'[47]. Because local communities may contribute to the project as collectors, providers of traditional knowledge, conservators of biodiversity, and in other ways.

Local companies (stakeholder '4') and local NGOs (stakeholder '5') were sometimes involved in ABS projects[48]. As for local companies, the scope of benefits seemed to focus on research and development and product development[49]. As for local NGOs, training and contributions to the local economy might be considered their main benefits[50].

A.2.3 Treatment of monetary benefit sharing

Viewing the time frame, we can simply divide monetary benefits into three types: near-term, medium-term, and long-term benefits. Access fees at the first stage of a project may belong to near-term benefits. Milestone payments, salaries, research funding and joint ventures may be categorised as medium-term benefits. Part of milestone payments, royalties and license fees may be included in long-term benefits.

Near-term monetary benefits

Up-front payments, such as access fees, are used in some contracts as near-term monetary benefits. Ten Kate (1999) reported a fee of USD 25-USD 200/kg per dry plant, which included collection, documentation and packaging, literature searches, shipping and staff salaries; for micro-organisms it was USD 20-USD 140 per unit sample. The price of samples may differ between raw materials and value-added products.

We identified several examples using near-term monetary benefits. These are access fees, extract licensing fees and up-front payments, offsetting any future royalties. In the Africa ICBG program, collection fees, about USD 50 000 (USD 30 000 in Nigeria and USD 20 000 in Cameroon), will be paid to individuals and communities over the first two years of the project from the ICBG budget for the payment of plant samples. In the Fiji case, a local academic organisation, the USP (University of the South Pacific), contracted with a broker, the SIDR (Strathclyde Institute of Drug Research at Strathclyde University), to provide extracted samples to a third party, such as a drug company. The local community receives 60 per cent of the extract licensing fees paid by the third party (about USD 20 per sample) through the USP, less the costs of extraction and transportation. In addition to up-front payments, these cases include the sharing of the other future monetary benefits in contracts. On the other hand, in the Yellowstone-Diversa case, a private firm provided Yellowstone National Park with an up-front payment of USD 100 000, payable in five yearly instalments of USD 20 000, to be offset against any future royalties. Sometimes, up-front payments had an important role in ABS contracts. But, up-front payments are rarely used to offset future royalties. In a situation where large amounts of samples will be required for follow-up studies or future needs, payments for the samples will be determined on a case-by-case basis.

46. In ICBGs and Fiji cases.

47. In ICBGs, Fiji and Ancistrocladus Korupensis cases.

48. In this study, local companies were only involved in the Suriname ICBG and the Calanolide case.

49. In Suriname ICBG and Calanolide cases.

50. In Africa ICBG, Suriname ICBG and Ancistocladus Korupensis cases.

Medium-term monetary benefits

As for medium-term monetary benefits, salaries, research funding and joint ventures are sometimes involved in projects. These benefits are provided as process benefits. Salaries are usually shared, but the sharing of research funding and joint ventures depends on the situation. These benefits require more responsibility on the part of the provider of genetic resources, as well as cost-sharing.

In the INBio-Merck case, Merck agreed to provide research funding of USD 1 135 million during the first two years of the agreement and to contribute to the INBio laboratory equipment and materials needed to operate the processing laboratory. In the Calanolide case, the Sarawak government and a private firm, Medichem Research (MR), established a joint venture to seek to complete development and commercialisation.

Long-term monetary benefits

As for long-term monetary benefits, royalty payments and license fees in case of commercialisation may be involved. Up to the present, there seems to be no examples of success developing a new medicine by utilising contracted genetic resources. Most contracts include monetary benefits, but there still remain several problems in determining the detail of those benefits. One problem in determining long-term monetary benefits is the share rate of royalty payments between user and provider, that is to say, what percentages of royalty payments should be shared with the provider of genetic resources. A second problem is the share rate of long-term monetary benefits among source stakeholders.

The share rate between user and provider

Percentages of net sales[51], in case of commercialisation, to be shared with the provider were usually confidential between the user company and provider organisations. Ten Kate (1999) estimated that for genetic resources it is to be 0.5 to 2 per cent (sales amount); when data with added value is provided it was estimated to be 1 to 4 per cent (sales amount); when important information for medicine development including animal experiment data is provided it is about 2 to 15 per cent (sales amount).

In determining royalty rates, consideration is given to the type of patent claims granted, potential product sales, the level of development and potential costs of subsequent research and development, marketing exclusivity to a private firm, the competitive impact of related marketed products, the degree to which the patents in question are dominated by the firm's patents, the necessity of paying royalties to third parties having dominant rights, and the extent of contributions of ethnobotanical knowledge or uses[52].

R&D costs and the low success probability in the development of a new drug are two of the uncertainties in determining the share rate of royalty income. But this is a controversial issue. For example, the Pharmaceutical Research and Manufacturers of America (PhRMA, USA) estimated that for every 5,000 medicines tested, on average, only five were tested in clinical trials and only one of those was approved for patient use. And average costs, including failed attempts, of bringing one new medicine to

51. For example, net sales means all amounts involved by a profit firm and its permitted sublicensees to an unrelated third party for the sales of any product, less sales and similar taxes: allowances, import duties and other governmental charges, discounts, rebates, credit freight or insurance, all to the extent actually taken or received by company and such sublicensees.

52. Written in the International Cooperative Biodiversity Grant Research Agreement among the VPISU, the B-MS, the CI, the MBG and the BGVS (draft) in the Suriname ICBG program.

market was USD 500 million. Also, it took an average of twelve to fifteen years to discover and develop a new medicine (PhRMA, 2000). Recently, a study from Tufts University in the USA used confidential survey data of ten pharmaceutical companies to conclude that the average cost to develop a new drug was USD 802 million. Using an alternative methodology, Love (2001) examined income tax returns of pharmaceutical companies and, in a paper prepared for the Consumer Project on Technology in the USA, argued that the cost of clinical trials for each new drug to treat rare diseases was substantially lower than is found in other studies. The Japan Pharmaceutical Manufacturers Association (JPMA) estimated that the success rate of new drug was approximately 1/6000. Examples in the agricultural sector show that the success rate in the seed industry was very low. The Centro Internacional de Mejoramiento de Maizy Trigo (CIMMYT) developed a series of 62 sister varieties of wheat known as Veery in the 1970s. The CIMMYT tested about 3,170 different crosses made by breeders around world.

There are few examples in this study to show the share rate between a user firm and the providers. In the Africa ICBG program, all royalties and other considerations generated from license of IPRs are divided in the following manner: 30 per cent to the WRAIR (Water Reed Army Institute of Research), a governmental organisation, 50 per cent to the BDCP (Bioresources Development and Conservation Programme)[53], a local NGO, and 20 per cent to be divided among those parties contributing intellectually to the creation of the IPR. Another example was the TBGRI-Kani case. The TBGRI (Tropical Botanical Garden and Research Institute), an academic organisation, will receive 2 per cent royalties on any future drug sales for seven-year license periods.

The determination of royalty rates depends on several factors. Private firms may contract with provider organisations of genetic resources at a certain royalty rate, based on their own experience of R&D costs, success rates for development of new products, as well as contributions from the providers with mutually agreed terms.

The share rate of long-term monetary benefits among source stakeholders

A second problem is the share rate of monetary benefits among stakeholders on the provider, that is to say, what percentages of monetary benefits received from users of genetic resources is shared. Among provider countries, this problem might involve domestic distribution issues, depending on the amount of contributions from each stakeholder and the allocation of its benefits.

In most cases in this study, local communities will typically receive at least 50 per cent of future royalties and the rest of royalties will be shared depending on contributions to the project from each stakeholder. In some cases, one part of future royalties will be set aside or used for conservation purposes or future purposes.

In the Africa ICBG program[54], 50 per cent of all royalty income and other considerations generated from the license of IPRs shall be donated to the BDCP to be used solely for programs and projects designed to promote sustainable economic development relating to biodiversity conservation in Nigeria and Cameroon. Half of the amount shared with the BDCP will be provided to traditional healer organisations[55] and community development funds based on relative contributions to the research and

53. The shared benefits to the BDCP will be used solely for programs and projects designed to promote sustainable economic development relating to biodiversity conservation.

54. Written in the Cooperative Research and Development Agreement among the WRAIR, the BDCP, the Compensation, Benefit Sharing Plan and Maurice (1998).

55. The Enugu State Branche of the Nigerian Union of Medical Herbal Practitioners (N.U.M.H.P) was established as an umbrella organisation for traditional herbalists living in Nigeria.

development process. The remaining of the royalty shared with the BDCP will go to local academic organisations, botanical gardens and others for the purpose of training or others.

In the Latin America ICBG program[56], in the event that a sample or information provided by an ethnobiologist or local people leads to the identification of a sample, local people shall get royalty through a trust fund. The University of Arizona (UA) shall deposit 50 per cent of any royalty, derived from net sales, received by the UA into the fund for specific local needs and conservation purpose. The remaining 45 per cent of royalty from the UA will get to the named inventors of the product.

In the Suriname ICBG program[57], in the case of ethnobotanical collection, the Forest People Fund (FPF), which was established to ensure that tribal communities would benefit immediately from the access granted to their forest resources, will receive 50 per cent of royalties. The percentages of future royalties, are split up as following: the two local NGOs, CI and STINASI, will receive 5 per cent and 10 per cent of royalties, respectively; the two academic organisations, NHS and SFS, will get 10 per cent and 5 per cent of royalties, respectively. In random collections, the FPF will get 30 per cent of royalties because samples were collected without any help from ethnobotanical knowledge. Remaining organisations will each receive 10 per cent of royalties

In the TBGRI-Kani case, from the 2 per cent royalties that will be payable to the TBGRI by a private firm on any future drug sales, local communities, the Kani tribes, will receive 50 per cent of the license fee, as well as 50 per cent of royalties. In the Fiji case, 60 per cent of total extract licensing fees will be given to the local communities.

In addition to this, in some cases, other monetary benefits were/will be shared with stakeholders. For example, access fees were shard with stakeholders in the Africa ICBG, the Fiji case, the Yellowstone-Diversa case and the Calanolide case.

A.2.4 IPRs and TK

Some cases explicitly address IPRs and/or TK in contracts. As for joint ownership of inventions, including patent rights, some cases (three ICBG programs, the Yellowstone-Diversa case, and the Calanolide case) dealt with it as an important matter. For example, the Suriname ICBG included provisions that 'All inventions made by a single Party including shamans (traditional plant users) of Suriname shall be owned solely by that Party or shaman. All inventions jointly made by more than one party shall be jointly owned by the related Parties. Any Party or shaman who is the sole owner of a subject invention shall have the first right to prepare, file, prosecute and maintain patent applications.' The INBio-Merck case provided similar provisions in its contracts. In the Yellowstone-Diversa case, Diversa, a user for profit organisation, was free to patent any innovations based on the specimens sampled, and to sell the resulting products, although the specimens transferred from the Park to Diversa were still owned by the Federal government. In the Calanolide case, the provider government and the user firm established a joint venture. Their patent royalties will be shared 50:50 in all IPRs arising out of the venture. Most scientific research and development was conducted jointly by both user organisations and provider organisations so that all inventions made by one organisation would be jointly owned by related organisations, from both the user and the provider. But inventions requiring highly-developed technology conducted mainly by a developed user country would be owned by the user.

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56. Written in the agreement between the UA and PUC.

57. Written in the International Cooperative Biodiversity Grant Research Agreement among the VPISU, the B-MS, the CI, the MBG and the BGVS (draft) and the Cooperation Agreement Regarding Research of Medicinal Plant among the Saramaka Tribe, the BGVS and the CI-Suriname (draft).

As for TK, some contracts, such as those of ICBG programs, address ethnobiological knowledge by traditional healers or local people explicitly. The Latin America ICBG program includes provisions in contracts stipulating that, in the event samples or information provided by an ethnobiologist or local people, or material collected from indigenous territory leads to the identification of a sample which is ultimately derived a product, one part of royalties should be deposited into a trust fund for specific needs and conservation purposes[58]. The Africa ICBG program addresses trade secrets in a provision saying that where confidential information is obtained from a source, such as a traditional healer, an agreement providing compensation to the source for disclosing the confidential information is required[59]. In the Suriname ICBG program, contributions from ethnobotanical knowledge could be recognised to be worth 20 per cent of royalties, because 50 per cent of royalties are shared in ethnobotanical collections (which require ethnobotanical knowledge) and 30 per cent of royalties are shared in random collections (which do not).

A.2.5 Earmarking of benefits for conservation purposes

ABS schemes are considered one good way of distributing benefits and costs for conserving biological diversity, both among income groups and in geographical terms. In ABS systems, there are several measures contributing to the conservation of biological diversity, both directly and indirectly. Direct measures include payments for conservation projects such as earmarking, training and capacity-building for biodiversity conservation and others. On the other hand, economic development of local communities, scientific information, institutional capacity-building for the administration and enforcement of access regulations, and so on, may have indirect impacts on the conservation of biological diversity in the source country.

Some cases provided examples of earmarking of benefits, including the three ICBG programs, the INBio-Merck case and the Yellowstone-Diversa case. In the three ICBG programs, one part of royalties from future commercial products will be distributed to trust funds for local conservation and development purposes in source countries. These funds will compensate local communities for their ethnobotanical contributions to ICBG programs, create conservation incentives for local communities, support sustainable management projects, and provide research and training exchanges. In the INBio-Merck case and the Yellowstone-Diversa case, source country governments played a major part in achieving earmarking of benefits. According to the agreement contracted between the INBio and the MINAE, one part of the research budget and royalties for all collaborated research agreements established by the INBio will be transferred to the MINAE[60] to be used for biodiversity conservation purposes. In the Yellowstone-Diversa case, money paid to Yellowstone National Park were to be paid into a special government account and earmarked for the Parks new conservation project, if this case is still in place

58. Written in the agreement between the University of Arizona (UA) and Pontificia Universidad Catolica in Chile.

59. Written in the Cooperative Research and Development Agreement for Drug Discovery and Biodiversity Conservation in the Africa ICBG program.

60. All collaborative research agreements established by the INBio stipulate that 10 per cent of the research budget and 50 per cent of future royalties will be given to the MINAE to be reverted to conservation. The remainder of the research budget supports process and scientific infrastructure within the country, as well as value-added activities also oriented to conservation and the sustainable use of biodiversity. (http://www.inbio.ac.cr/)

A.3 Findings

There are many stakeholders involved in benefit sharing issue with different viewpoints and interests. Many countries and international organisations, moving the same direction, have introduced, or are just drafting, regulations or international frameworks to give efficacy to CBD provisions. To find the best way to resolve this issue, user countries, especially developed countries, like OECD member countries, should cooperate with provider side countries from an interdisciplinary point of view, including legal, political, economic and scientific aspects.

There are many factors influencing the determination of benefit sharing mechanisms, such as the aim of projects, the role of each stakeholder, and others. Project aims may result in differences in project type and size, as well as its main actors. If government plays a major role in a project, the project may also have cooperative characteristics as well as product development and commercialisation objectives. The role of each stakeholder influences the determination of the scope of benefits. Each stakeholder may have several roles in a project, especially local communities and academic organisations. Local communities might contribute to the project as collectors, providers of traditional knowledge, conservators of biodiversity, and others. Local academic organisations might play a role as supporters of collection activities, executors of scientific research and development, and sometimes as collaborators of product development, and others.

Process benefits might be recognised as a main component of benefit sharing schemes, although long-term benefits, such as payment of royalties, are a part of benefits in most cases. As for specific benefits, the determination of royalty rates depends on several factors. On the other hand, the share rate of monetary benefits among local stakeholders might be considered a domestic issue. The former will be decided, with mutually agreed terms, based on past experience regarding R&D costs, low success rates for the development of new products in each private company, and others, as well as contributions from the providers. IPRs, TK and earmarking of benefits for conservation purposes were recognised in contracts in several cases. There still remains some disagreement among many stakeholders on these points.

There may be several issues to be addressed in future studies. Firstly, the total number of cases available in this study was only thirteen. The second problem was the imbalance of user countries (most of the cases came from the USA). The third problem was the small number of cases where the main actors were private companies (because of confidential contracts). Unfortunately, from the viewpoint of the country variety and the purpose of usage of genetic resources, we could not find major distinguishing characteristics in our study of the scope of benefits and stakeholder roles. These problems should be considered for future work because these types of cases involve many of the main factors influencing decisions on benefit sharing mechanisms.

Main Actors

Africa ICBG

- WRAIR: The Water Reed Army Institute of Research (USA)
- STRI: The Smithsonian Tropical Research Institute (USA)
- S.ph: Sharman pharmaceuticals Inc., (USA)
- The Healing Forest Conservancy
- BDCP: The Bioresources Development and Conservation Programme (BDCP)(in association with the University of Yaounde, Cameroon and the University of Nigeria, Nsukka)
- U. Dschang: The University of Dschang (Cameroon)
- U. Ibadan: The University. of Ibadan (Nigeria)
- Inter CEDD: The International Centre for Ethnomedicine and Drug Development (Inter CEDD) (Nigeria)
- N.U.M.H.P: The Nigerian Union of Medical Herbal Practitioners (N.U.M.H.P) Enugu State Branch (Nigeria)

- Umikabia U.: The Umikabia Development Union (Nigeria)
- Owai C.: The Owai Community (Nigeria)
- ESFD: The Enugu Satae Forestry Department for the rehabilitation of Enugu Regional Herbarium (Nigeria)
- MEF: The Ministry of Environment and Forest (Cameroon)

Suriname ICBG

- VPISU: The Virginia Polytechnic Institute and State University (USA)
- MBG: The Missouri Botanical Gardens (USA)
- B-MS: The Bristol-Myers Squibb Pharmaceutical Research Institute (USA)
- CI: The Conservation International
- STINASU: The Foundation for Nature Preservation in Suriname (Suriname)
- NHS: The National Herbarium of Suriname (Suriname)
- SFS: The Suriname Forest Service (Suriname)
- The University of Suriname (Suriname)
- The Saramaka Tribe (Suriname)
- BGVS: The Bedrijf Geneesmiddelen Voorziening Suriname (BGVS), a pharmaceutical company owned by the Surinamese government (Suriname)

Latin American ICBG

- UA: The University of Arizona(USA)
- AC: American Cyanamid Company (USA)
- INTA: The centro de Investigaciones de Recursos Naturales del Instituto Nacional de Tecnologia Agrooecuaria (Argentina)
- UNP: The Universidad Nacional de la Patagonia in Argentina (Argentina)
- PUC: The Pontificia Universidad Catolica de Chile (Chile)
- UNAM: The Universidad Nacional Autonoma de Mexico (Mexico)
- UP: The University of Purdue (USA)

BRCP

- NEDO: The New Energy and Industrial Technology Development Organization (Japan)
- JBA: The Japan Bioindustry Association (Japan)
- NSTDA: The National Science and Technology Development Agency (Thailand)
- RFD: The Royal Forest Department (Thailand)
- TISTR: The Thailand Institute of Scientific and Technological Research (Thailand)
- QBG: The Queen Sirikit Botanical Garden (Thailand)
- NCGEB: The National Center for Genetic Engineering and Biotechnology (Thailand)
- BPPT: The Agency for the Assessment and Application of Technology (Indonesia)
- IPB: The Bogor Agricultural University (Indonesia)
- ITB: The Institute of Teknologi Bandung (Indonesia)
- UGM: The Gadjah Mada University (Indonesia)
- LIPI: The Indonesian Institute of Sciences (Indonesia)
- UNPAD: The Universitas Padjadjaran (Indonesia)
- MOSTE: The Ministry of Science, Technology and the Environment Malaysia (Malaysia)
- NBD: The National Biotechnology Directorate (Malaysia)
- SIRIM: The Standards and Industrial Research Institute of Malaysia (Malaysia)
- UM: The University Malaya (Malaysia)
- USM: The University Sains Malaysia (Malaysia)
- UKM: The University Kebangsaan Malaysia (Malaysia)

- UPM: The University Putra Malaysia (Malaysia)
- UNIMAS: The University Malaysia Sarawak (Malaysia)
- FRIM: The Forest Research Institute Malaysia (Malaysia)
- MARDI: The Malaysia Agriculture Research Development Institute (Malaysia)

Fiji

- SIDR: Strathclyde Institute of Drug Research at Strathclyde University (UK)
- BCN: The Biodiversity Conservation Network
- ProG: The provincial government (Fiji)
- DeE: The Department of Environment(Fiji)
- USP: The University of the South Pacific (Fiji)
- Verata trib: TheVerata Coastal Community (Fiji)
- SPACHEE: The South Pacific Action Committee for Human Ecology and Environment

INBio-MERCK

- Merck: Merck & Co.,Inc.(USA)
- INBio: The Instituto Nacional de Biodiversidad(Costa Rica)
- MINAE: The Ministry of Environment and Energy (Costa Rica)

Ancistrocladus Korupensis

- NCI: The National Cancer Institute (USA)
- MBG: The Missouri Botanical Garden (USA)
- KNP: The Korup National Park (Cameroon)
- Korup: Local communities of the Korup area (Cameroon)
- GoC: The Government of Cameroon (Cameroon)
- U.Y: The University of Yaounde (Cameroon)
- P.U.: The Purdue University

Calanolide

- NCI: The National Cancer Institute (USA)
- MR: Medichem Research (USA)
- UIC: The University of Illinois at Chicago (USA)
- GoS: The State Government of Sarawak (Malaysia)
- SMP: The Sarawak-Medichem Pharmaceuticals (Malaysia: a joint venture between GoS and MR)

UC Davis

- UC Davis: The University of California at Davis (USA)
- St.U.: The Stanford University (USA)
- IRRI: The International Rice Research Institute (the Philippines)

Yellowstone-Diversa

- YNP: Yellowstone National Park
- Diversa: Diversa Corporation
- WFED: The World Foundation for Environment and Development (USA)

TBGRI-Kani

- FoD: The Forest Department (India)
- RRL: The Regional Research laboratory (India)

- TBGRI: The Tropical Botanical Garden and Research Institute (India)
- The Kanis tribals (india)
- AVP: Arya Vaidya Pharmacy Ltd (Inida)

ABBREVIATIONS

ABS	Access and benefit sharing
CBD	Convention on Biological Diversity
INBio	Instituto Nacional de Biodiversidad
IPR	Intellectual Property Rights
MC	Marginal cost
MRS	Marginal rate of substitution
R&D	Research and development
WTP	Willingness to pay