

Article

Access and Benefit Sharing under the Convention on Biological Diversity and Its Protocol: What Can Some Numbers Tell Us about the Effectiveness of the Regulatory Regime?

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Abstract: The Convention on Biological Diversity (CBD), adopted in 1992 and entered into force at the end of 1993, established a global regime on access to genetic resources (GR) and sharing of benefits arising from their utilization (Access and Benefit Sharing (ABS) regime). Its protocol—the Nagoya Protocol (NP)—which entered into force 21 years later in 2014, clears up some terminological ambiguities of the Convention, clarifies and develops several procedural and instrumental elements of the regime, and obliges States Parties to implement some of its provisions, including the core instrument of the regime: the bilateral ABS agreement between users and providers of GR, that became a condition for obtaining access to the resource. However, scholars who analyzed the ABS regime as well as its official bodies find, and sometimes deplore, the small number of ABS agreements concluded so far, under the CBD as under the NP. This paper has two objectives: First, to assess the effectiveness of the ABS regime implemented by the CBD and the NP on the basis of its central instrument: the ABS agreements concluded between users and providers of GR. The aim is to accurately document the number of ABS agreements concluded since the entry into force of the regime. To our knowledge, such a counting that is neither piecemeal nor has an estimate yet been produced. To do so, I combine several sources, including first hand data collected from the official information agencies—the National Focal Points (NFP)—of each of the States Parties to the NP. Second, I provide a critical summary of the existing explanations of the low number of ABS agreements concluded and I evaluate the corresponding causal mechanisms, relying on the results I obtained regarding the number of permits and agreements.

Keywords: Access and Benefit Sharing; Convention on Biological Diversity; Nagoya Protocol; ABS agreements

1. Introduction

1.1. Context

Over the past 40 years, enormous advances have been made in life sciences disciplines. Since the 1970s, it has been possible to act directly on the genetic material contained in the nucleus of the cells of living organisms [1]. DNA became a source of value, a resource, the genetic resource (GR). Almost simultaneously the decline of biodiversity (in other words the genetic diversity among and within species) has been recognized as a major environmental issue of global scope [2].

For almost half a century, GR are the subject of intense debates and rivalries which mainly concern (1) their appropriation through material and intellectual property rights (IPRs); (2) the necessity to conserve them and use them sustainably; and (3) the effects of their manipulation through genetic engineering technics.

Numerous public policies, on all jurisdictional and institutional levels, were implemented to address public problems arising from the utilization of GR. Among these policies, the Convention on Biological diversity (CBD) aims to regulate the uses of biodiversity. One of the objectives of this treaty is the implementation of an Access and Benefit Sharing (ABS) mechanism. In other words, through the CBD, the international community wanted to establish a global regime regulating the access to GR which are used to perform scientific researches so as to enable the fair sharing of the benefits that may arise from those research activities. Although important efforts have been undertaken to make such a regime effective, culminating with the adoption of a binding protocol to the CBD—the Nagoya Protocol (NP)—in 2010, important and numerous reservations were expressed by scholars [3–7], researchers dealing with GR [4,8–10], as well as by countries which provide GR [1,4,11–13] on the regime’s capacity to achieve its objectives. The purpose of this article is to empirically verify how those doubts about the effectiveness of the ABS regime are confirmed by the results the regime obtained so far, based on its core instrument: the ABS agreements concluded between users and providers of GR. At a time when the majority of States Parties to the CBD or NP are still in the process of adopting the national ABS legislations that will implement the regime, it seems both scientifically relevant and useful in terms of public policy to compare theoretical knowledge of ABS as well as practical experiences of it with empirical data on its functioning on a global scale.

1.2. *The Genetic Resource and Its Utilization*

Genetic materials are directly used through three sets of biotechnological techniques [14]:

- **Selective breeding and artificial selection**, which is the selection of organisms with useful properties by producing targeted mutations on their genomes or by crossing directly their genomes (cell fusion, molecular markers, etc.).
- **Genetic engineering**, which is the modification of genomes by removing genetic material or by adding sequences from other organisms, which belong or not to the same species.
- **Synthetic biology**, which is the artificial creation of biological systems (naturally occurring or not) by adding artificial DNA sequences to a minimal natural genetic ‘frame’ or by assembling segments of artificial DNA to build a functional system.

The technical capacities of manipulating genetic material have made it a resource in its own right. The benefit flows arising from GR are exploited through the production systems of biotechnology (A series of colors is usually used to identify several branches of biotechnology: green for agricultural and environmental biotech, red for pharmaceutical and other medical related biotech, blue for marine and coastal biotech, yellow for food and nutrition biotech, and white for biomaterial and other industrial process biotech).

It should also be mentioned that numerous indirect utilizations of the genetic materials of organisms are constantly performed. Traditional breeding of cows or the extraction of essential oils from plants belong to these indirect uses of genetic properties, which in other words are the utilization of the material results of the biochemical processes induced by the genetic material. I return to this issue at the end of Section 1.4.

1.3. *Material and Intellectual Property Rights over Genetic Resources*

The biotechnology sector emerged in the 1970s and, with it, the will to protect the new corresponding inventions [1,15]: From the first successes of each of these techniques, intellectual property rights (IPRs) on newly extracted, isolated, purified, modified, or artificially created GR have been claimed and, more or less rapidly depending on the case, granted [16–19]. If the material property

over organisms (a herd of sheep, a plant nursery, etc.) is as old as the domestication of plants and animals, it has traditionally been assumed that no IPRs over living matter can be granted. Most IPR legislations require, for protection to be granted, that the IPR is claimed over an invention and not over the simple discovery of something already existing. Yet, biological matter, as a manifestation of Nature, cannot be invented, but only discovered. The living was thus considered to be part of a common heritage of humanity, which cannot be appropriated by IPRs [1,15,20,21]. However, the molecular biology techniques mentioned above started to challenge this doctrine. The direct manipulation of GR changed their status, from product of Nature to product of the ingenuity of the human mind and therefore qualified them as possible candidate for protection by IPRs. During the year 1980, a Supreme Court decision (The US Supreme Court decision in *Diamond v. Chakrabarty's* case, which legalized the patentability of a genetically modified bacterium.) and the adoption of the Bayh-Dole Act (The Bayh-Dole Act is a patent law passed by US Congress, that allows publicly-funded research teams to patent their discoveries (including on living matter) and encourages them to build partnerships with the private sector) [3], both in the United States, made the obtainment of IPRs over living beings possible. The general principle of this legal reversal is the following: once the natural GR has been genetically modified, it can be patented, provided that the modification in question is new, applicable within an industrial process, and can be considered as an invention [16,19]. Since then, patenting has become a widespread practice, first in the United States, then in Europe [3,16,18,19].

1.4. Global Regulation of Genetic Resources Utilization

Concerns about the appropriation of GR through IPRs met environmental ones in the 1980s, as discussions started on the necessity to adopt a global framework regulating biodiversity utilizations. At the time, the environment had already become a political issue and the erosion of biodiversity a public problem of global importance [2]. Southern States, many of whom were newly independent at that time, contested the GR's status as a common heritage of humanity. They considered it to be an insidious form of colonialism led by the northern agrochemicals and pharmaceuticals industries [1,13,20,21]. Rather paradoxically, the nationalist demands of GR suppliers were coupled with users countries' will to support their biotechnology industry: the suppliers countries' request of national sovereignty over GR located within their territories was perfectly acceptable to actors of the biotechnology field, as they saw it as an opportunity to extend the international IPR regime to living matter [13]. In a nutshell, the deal was to exchange national sovereignty over GR for the possibility to claim IPRs on these resources.

Thus, an ad hoc Working Group of Technical and Legal Experts (who became the so called Intergovernmental Negotiating Committee) established by the United Nations Environment Program (UNEP) was able to submit a draft convention for an international regulatory regime on the uses of all living natural resources. The final text was accepted in 1992 during the Nairobi Conference for the Adoption of the Agreed Text of the Convention on Biological Diversity. The Convention on Biological Diversity (CBD) was adopted the same year at the United Nations Conference on Environment and Development (the Rio "Earth Summit") and entered into force in December 1993.

The scope of the regime established by the Convention on Biological Diversity (CBD) extends to the genetic material of plants, animals and microorganisms, which means [22] "(. . .) any material of plant, animal, microbial or other origin containing functional units of heredity". The regime pursues a triple objective: to conserve genetic diversity, make its uses sustainable, and ensure an equitable sharing of the benefits flows derived from them. The legal concept of access and benefit sharing (ABS) refers to this last objective. With ABS, the request of Southern States on property rights over GR was integrated to the regime by granting to each State a sovereign right over the GR situated on its territory. Concretely, this means that the material ownership of GR belongs to the States and that they have sole competence to decide under what conditions access to 'their' GR can be granted and resulting benefits shared [1,21].

The regime is based on two categories of instruments to achieve its objectives. First, in order to conserve biodiversity and encourage sustainable utilization of biological and genetic resources, CBD States Parties are invited to develop and implement plans, strategies or programs. Second, regarding equitable sharing of the benefits, private law contracts are the core instrument. They formalize the arrangements concluded between a GR supplier state and a particular user by stipulating which GRs are used, for which purposes, and how any corresponding benefits could be shared. In this perspective, equity, conservation and sustainability are supposed to be linked by a “virtuous” cyclical process: monetary and non-monetary benefits shared by the users with the providers of the initial GR are (at least partially) used to support conservation and sustainability, through the funding of corresponding measures. Additionally, provider states and their local populations are encouraged to preserve their genetic capital, as the regime makes it a source of income.

Several alternative ABS regimes have been implemented. These regimes are distinguished by two main dimensions: the degree of cooperation between the actors and the nature of property rights on GR (which determines the conditions of access, use and exchange). Significant examples include the introduction of common pools of (free access to the resources and multilateral sharing of the benefits) seeds in order to ensure food security. The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), adopted by the Food and Agriculture Organization of the United Nations (FAO) in 2001 and into force since 2004, established such a common pool of GR, called the Multilateral System (MLS). The MLS was elaborated in accordance with the CBD provisions but it differs from the Convention on several points. It is legally binding and aims at the conservation and sustainable use of food crops of extreme importance to global food security as well as the equitable sharing of benefits derived from these GR. It applies to 35 varieties of food crops and 29 forage varieties, which make up more than 80% of the caloric intake coming from plants in the human diet [18]. These GRs are co-owned, improved, and traded almost everywhere in the world. States Parties must grant unrestricted access to these varieties. The monetary and non-monetary benefits are shared among all States Parties through a common fund and the corresponding knowledge and information are collected in a common database. The facilitating exchange system proposed by the MLS has been successful in terms of the volume of material exchanged [18].

Originally, the ambition of the international community was the adoption of an “umbrella convention”. In other words, a treaty able to absorb and consolidate the numerous existing regional and global conventions dealing with the different aspects of biological diversity. The members of the Working Group of Technical and Legal Experts finally concluded that such an “umbrella convention” was both legally and technically impossible to set up [23]. As a result, the CBD took the form of a “framework convention”, an intentionally loose and flexible treaty [24] that features the founding principles of the cooperation between concerned States Parties in the specific field of biodiversity. The idea behind an instrument like the framework convention is to stagger the establishment of norms: first, the framework convention establishes the legal bases and principles; then, States Parties have the authority to implement them independently through national legislation [25].

A framework convention is equivalent to the convention-protocol approach: after agreeing on relatively vague core principles, States Parties continue to meet regularly in order to adopt more specific and binding collective rules on particular subjects related to the original convention. Their formal manifestation is often a protocol to this convention [24].

This is typically the case with CBD: one year after the Convention entered into force, States Parties have begun to meet periodically within the context of the Conferences of the Parties (COP) for further negotiations. The implementation of the CBD through national ABS legislations in States Parties proved to be particularly difficult regarding its third objective of fair benefit sharing. The cooperation between Parties was not optimal as user countries had not assisted providers in this task [11]. Concerns about the possible free use of GR despite the adoption of the Convention incited the States Parties to implement a set of binding rules dealing with the ABS elements of the CBD. In 2002, in Cancun (Mexico), several megadiverse countries set up the Group of Like-Minded Megadiverse Countries (GLMMC) (Bolivia,

Brazil, China, Colombia, Costa Rica, Democratic Republic of the Congo, Ecuador, Ethiopia, Guatemala, India, Indonesia, Iran, Kenya, Madagascar, Malaysia, Mexico, Peru, Philippines, South Africa, and Venezuela). The origins of this group of countries go back to 1998, when Conservation International, a US non-profit environmental NGO established a list of the countries harboring the majority of Earth's species, the 17 megadiverse countries (Australia, Brazil, China, Colombia, Democratic Republic of the Congo, Ecuador, India, Indonesia, Madagascar, Malaysia, Mexico, Papua New Guinea, Peru, Philippines South Africa, United States, and Venezuela). This group is the political expression of the interests of this minority of Southern States accounting for the majority of the existing GR. During the negotiations of the NP, the GLMMC has been a megaphone for the developing countries, defending strong views on the ABS related issues (like compliance measures from user States). It took 10 COPs to agree on a binding protocol to the Convention—the Nagoya Protocol (NP)—adopted in 2010 [1].

States Parties to the NP are required to adopt a clear national ABS legislation. Provider countries have to put procedures into place to regulate access GR situated on their territory. Access to the resource is granted through an access permit whose deliverance is conditioned by the obtaining of the Prior Informed Consent (PIC) of the Competent National Authority (CNA, the official body entitled to regulate ABS according to the corresponding national legislation) or additional providers (local community, individual, etc.) if applicable. Basically, PIC embodies the consent of the provider on the basis of the information given by the user regarding the research he intends to conduct (description of the GR and the sampling sites, quantity of samples, duration of the access requested, etc.). Once a PIC is obtained, user and provider have to agree on the Mutually Agreed Terms (MAT). The MAT constitute a bilateral private law contract that establishes the conditions of access, uses of the resource and the sharing of benefits (commercial or non-commercial research purposes, amount of monetary benefits to be shared, payment terms, etc.). As a user country, a State Party has to ensure itself that GRs used through R&D programs on their territory were obtained in accordance with the provisions of the providers' ABS legislation. If that is not the case, they must take compliance measures.

Regarding the scope of the NP, it is based on the same definition of GR as the CBD but clarifies however [26] that: “Utilization of genetic resources’ means to conduct research and development on the genetic and/or biochemical composition of genetic resources”. This is considered to be an important improvement as it means that ABS rules also applies to derivatives, the variety of (bio)chemicals compounds extracted from GR (enzymes, flavonoids, alkaloids, etc.) [11]. Therefore, by enlarging the scope of the regime to the biochemical compounds from GR but that do not themselves contain functional units of heredity, a wide range of R&D became concerned with ABS requirements. Only research and developments activities though fall within the scope of ABS, which means that for example the supply of a plant GR to extract an already known active compound will not be regulated by the NP, as such activities do not encompass research and development.

As of November 2016, the CBD has 198 States Parties. Since the adoption of the NP in 2010, 79 States Parties to the CBD signed and ratified it, thus becoming States Parties to the NP. Half of those 79 countries have a national ABS legislation in force. Regarding States Parties to the CBD only, 17 countries implemented a national ABS legislation. This latter group of countries includes the members of the Andean Community (Bolivia, Colombia, Ecuador, and Peru) who have implemented an alternative ABS regime based not on the NP but on the Decision No. 391 Establishing the Common Regime on Access to Genetic Resources adopted in 1996.

In short, there are four relevant groups of States Parties in regard to the CBD and the NP:

- (I) States Parties to the NP: 79 countries
- (II) States Parties to the NP with a ABS legislation in force: 22 countries
- (III) States Parties to the CBD: 119 countries
- (IV) States Parties to the CBD with a ABS legislation in force: 17 countries

The following figure details this typology of countries (I used the data published by the Access and benefit-sharing Clearing-house (ABSCH): <https://absch.cbd.int>. ABSCH is the official platform for collecting information on ABS. I also used information collected through our survey and the following sources: [27]; several documents found on The ABS Capacity Development Initiative's website (<http://www.abs-initiative.info>), a multi-donor initiative supporting stakeholders from Africa, Caribbean and the Pacific for the implementation of national ABS.):

2. Purposes of the Study

The main purpose of this contribution is to test the two explanations I found in the literature, which try to explain the poor results of the ABS regime in terms of so far issued access permits and concluded ABS agreements. To do so, I first used empirical data to confirm these poor results. Then, I used the same data as well as additional information obtained through interviews conducted with experts and other relevant second-hand information to test the validity of the causal mechanisms assumed by the two explanations.

2.1. Estimation of the Number of Permits Issued and ABS Agreements Concluded

Key publications on the ABS regime implemented through the CBD and its protocol note its difficulties, so far, in achieving its objectives, as very few ABS agreements have been concluded and consequently very few benefits have been shared [2,3,6–8,28–30].

However, to our knowledge, there is not any accurate counting of either access permits granted or ABS agreements concluded since the entry into force of the CBD or the NP. I found piecemeal information indicating that the number is small but no systematic inventory. I consider that providing reliable data about access permits and ABS agreements is essential to analyze the concrete functioning of the regime. This is the core aim of our contribution. To get a picture that includes as many countries as possible, I combine two sources of data.

2.1.1. Data Collected from an Online Survey

In September 2016, I sent a survey by e-mail to contact persons of the National Focal Points (NFP) (NFP are official agencies that provide information on national ABS procedures and relevant stakeholders.) listed on the Access and Benefits Sharing Clearing-House (ABSCH) (ABSCH is the official information portal established by the NP. Parties have to submit relevant data to the ABSCH which has a role of information-hub). I submitted it to all NFPs of the States Parties to the NP (82 countries) and to the 16 countries that are Parties only to the CBD and have a ABS legislation in force (Afghanistan, Australia, Bolivia, Brazil, Brunei, Colombia, Costa Rica, Ecuador, Malaysia, Morocco, Nicaragua, Panama, Polynesia, Salomon Islands, Singapore, Thailand, and Venezuela).

It contained three questions (the last one was asked only to the States Parties to the NP):

- How many ABS agreements have been concluded in your country?
- How many access permits to GR have been issued in your country?
- If possible, could you indicate the proportion of agreements/permits that have been concluded/issued before and after your country became a State Party to the NP?

I could have focused exclusively on States Parties having an ABS legislation in force in their national legislative arsenal, as they are the only one where access permits and agreements can be found a priori. Nevertheless, I considered I had to verify if States Parties still lacking such a legislation had already collected data about GR accessed in their countries or used tools similar to permits or agreements but eventually based on other legislation (like any environmental one) to regulate the access to their GR.

On the 96 surveys I sent (79 States Parties to the NP and 17 States Parties to the CBD only), I received only 23 answers (response rate = 23.95%). Among the States Parties to the NP, I received answers from Bhutan, Burundi, Cambodia, Comoros, Croatia, Czech Republic, Ivory Coast, the European Union, Finland, Germany, Guyana, India, Norway, Rwanda, Slovakia, Spain, Switzerland, Togo, and UK. Among the States Parties to the CBD, I received answers from Costa Rica, Ecuador, Malaysia, and Venezuela. I did not expect such a low response rate, especially because I took pains to send the survey specifically to the individuals in charge of the NFPs. It is likely that the States Parties without an ABS legislation in force do not have data to share. This could explain the result. Concerning the States Parties belonging to the groups II and III (Figure 1) that did not answer, some of them could have considered these data sensitive and preferred not to communicate on that matter.

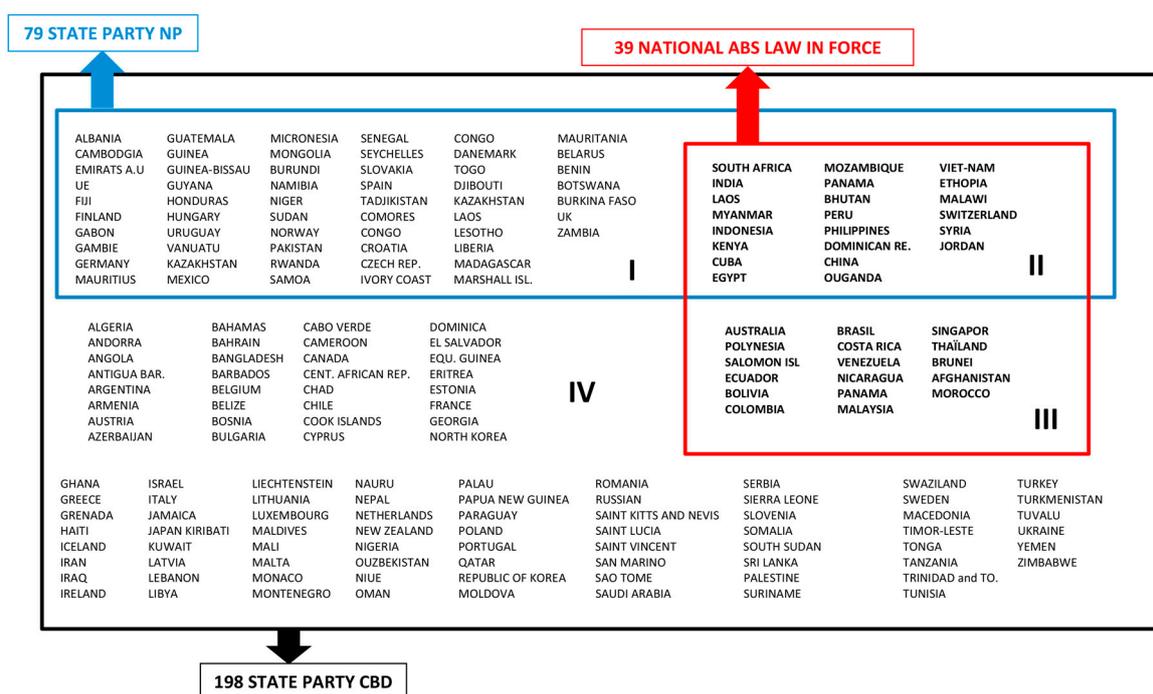


Figure 1. Groups of States Parties to the CBD and the NP.

2.1.2. Data Collected from Secondary Sources

To compensate the low response rate to our survey, I used several secondary sources, including scientific papers, previously conducted interviews, and annual reports of competent national authorities. As I could not search the relevant information for all the 76 countries I did not receive answers from, I focused on the countries having an ABS legislation into force and those hosting the most GR. I found relevant additional data about Australia, Bolivia, Brazil, Colombia, Cuba, Indonesia, Mexico, Peru, and South Africa. Finally, with the first and second-hand data, I covered 33.33% of the 96 States Parties I wanted to get information about. Although, it is still a low coverage rate, our sample is composed by almost all the potentially most important provider countries, where the regime is the most likely to show results in terms of agreements and permits. I consider that the representativeness of this sample allows us to draw some lessons from the results obtained regardless.

2.1.3. The Access and Benefits Sharing Clearing-House as Source of Data

As mentioned in Section 1.4, the ABSCH is the official information portal of the ABS regime established by the NP. According to [31], States Parties shall notify the ABSCH about the issuance of a Certificate of Compliance as evidence of the decision to grant PIC and of the establishment of MAT. [32,33] state that Parties shall also notify the Secretariat about the NFP and CNA they designated

and that the Secretariat shall make those information available through the ABSCH. Finally, [34] states that “Without prejudice to the protection of confidential information, each Party shall make available to the Access and Benefit-sharing Clearing-House any information required by this Protocol, as well as information required pursuant to the decisions taken by the Conference of the Parties serving as the meeting of the Parties to this Protocol”. Thus, by consulting the ABSCH’s website, one should be able to know what the requirements regarding ABS are in any State Party, whom to contact to get more information (NFP), which agency has the competency to issue the PIC and conclude the MAT (CNA) as well as information about the Certificates of Compliance, namely the PICs and MATs that have been concluded so far.

The ABSCH was indeed very useful to obtain an updated list of the States Parties to the CBD or NP having a national ABS legislation in force and an updated list of the NFP I wanted to send my survey to. Unfortunately, the platform turned out to be disappointing to get data about access permits, ABS agreements or any other evidence of access to GR regulated by the regime. Only four States Parties published such data (although they are required to): Guatemala (one case), Mexico (one case), South Africa (two cases), and India (46 cases), the latter being by far the best performer in terms of sharing this information.

2.2. Critical Review of the Current Existing Explanations of the Numbers of Permits and Agreements

The second aim of this contribution is to discuss the existing explanations of the poor results of the ABS regime in terms of access permits and agreements concluded that can be found in the literature. To discuss them, I relied on the numbers collected (Table 1), on several scientific contributions and on data from interviews conducted with an agronomist, head of a (public) research team working on plant improvement and a professor of genetics as well as data collected from presentations (and following informal discussions) given at a conference (in Switzerland) specially organized to inform non-commercial academic researchers working with GR about ABS requirements.

Scholars and officials mention several reasons that can be distinguished between two distinct causal mechanisms:

- (1) Very few contracts have been concluded because the implementation of national ABS laws by States Parties is incomplete or dissuading potential users to request access to GR:
 - Only a small minority of States Parties to the Convention or Protocol have been able to put in place the corresponding national legislations. This is notably due to a lack of technical expertise, lack of sufficient budget, lacking strong enough government structures and political support, local social conflict, and conflict over ownership of GR [35].
 - Among the few states that have succeeded in adopting ABS legislation, several have developed fragmented and ambiguous legal frameworks with poorly defining competencies, multiplying PIC to be obtained from different stakeholders and on the basis of different laws. Some existing legislations require long, cumbersome, and complicated procedures to establish MATs or obtain access [6,12]. They also do not offer sufficiently distinct procedures between access requests for basic and commercial researches [4,12]. The adoption of such restrictive legislations is explained by the expectations among provider countries that they will get money from the ABS mechanism and their will to put an end to the free and abusive utilization of “their” GR [4]. The lack of willingness by user countries to put measures into place to monitor compliance with the provisions of supplier countries is also mentioned as one of the factors that have made provider countries particularly cautious and pushed them to adopt restrictive access conditions to their GR [11,12]. Indeed, once the GR has left the provider’s territory, the latter has no way to monitor that the downstream process of R&D complies with the provisions of the corresponding ABS agreement. The insurance that user countries would monitor downstream process in that regard was therefore crucial for provider States. That was, and

still is, a source of major disappointment for them and they responded to it by adopting restrictive ABS provisions [4,11].

- (2) Very few contracts have been concluded because of a lack of demand for GR by potential users
- The high demand for GR that was anticipated during the 1990s has not been confirmed. The entry into force of the CBD is already 22 years old and progress in the field of biotechnology has profoundly modified the research processes as well as the research strategies of the pharmaceutical, agrochemical, food, and cosmetic firms. On one hand, it became possible to probe more deeply the GR research teams already have in their immediate environment or in the numerous *ex situ* collections they can freely access [8]. For example, in the agrochemical and seed sectors, the major actors of the industry use mergers and acquisitions to extend their collections of GR. The seed industry has been consolidating strongly over the last 30 years. The numerous small actors of the market (and most importantly the varieties, genes or technologies they possess through IPRs) are bought by a few multinationals through mergers and acquisitions [10,36–38]. As a result, in the early 2000s, emerged the so-called “Big Six” group composed of Syngenta, Bayer, Monsanto, DuPont, Dow, and BASF. These consolidated groups are active in both the agrochemical, seed, and pharmaceutical sectors. For the seed market in particular, the five largest groups hold more than 45% of the market share in terms of sales volumes [36]. Consolidation has a direct effect on plant GR exchanges as well as, although to a lesser extent, on bioprospection for wild GR. Indeed, this industrial strategy of both vertical and horizontal integration aims among other things to obtain IPRs (mostly patent) via the purchase of the small companies that have those IPRs over biotechnology technics, traits (genes), organisms, etc. [9,10]. Consolidation thus proportionally increases the catalog of GR at the disposal of the “Big Six”, whether these GR are protected by a plant breeders right or a patent. Consequently, these ‘giant’ actors escape the ABS regime, as they are not (or to a minimal extent) requesting access to foreign GR.
 - On the other hand, high throughput screening and combinatorial chemistry make it possible to generate whole libraries of molecules to be tested on various biological targets without having to rely on the diversity of natural compounds and in a faster and cheaper way than the latter [9]. As a result, there is a decline of interest for the search for exotic GR—the so called “green gold”—since the 1990s [3,29].
 - Moreover, if GR are used through biotechnology technics, only a minute amount of the resource is needed to conduct R&D program (sequencing, amplification, eventually artificial reproduction, etc.), which makes the monitoring of access difficult and the resupply unnecessary. Metagenomics represent an “extreme” aspect of this evolution as it makes it possible to extract genetic material from complex environmental samples, without having to deal with the organisms carrying it [9]. Finally, because of scientific advances, the interest for GRs has shifted to micro-organisms. This evolution has several decreasing effects on demand for access to GR: the origin of micro-organisms is far more difficult to identify, one can easily access microbes through vast and freely accessible collections or by collecting samples in his own backyard [9].

Those two distinct general causal mechanisms explaining the poor success of the ABS regime in terms of permits granted and agreements concluded do not exclude each other. The lack of interest showed by users in accessing GRs can be due to both alternative technical R&D options and discouraging ABS procedures. The pharmaceutical industry for example has mentioned the uncertainties around ABS requirements as one of the causes that led to a decline in its natural products research in the last decade [4]. Nevertheless, the implications of the two causal mechanisms are fundamentally different with respect to the functioning of the regime and the possibility to improve it. Indeed, if natural GRs are becoming a significantly less interesting raw material for R&D activities in

pharmaceutical and other biotechnology sectors, no matter how the ABS legislations could be improved and the corresponding procedures facilitated, the regime lacks both the activities it is supposed to regulate and the source of its redistributive mechanism. That is why an evaluation of the causal effect of the two causal mechanisms (1. implementation difficulties and 2. scientific/technological alternatives) is useful to assess the capacity of the CBD-PN's regime to achieve its objectives.

The data concerning the numbers of access permits and ABS agreements I have been able to obtain are not sufficient to determine, among the complex combination of factors simultaneously working in the two causal mechanisms, which one is likely to produce the most important effect. Nevertheless and although they are incomplete (as data from several countries are missing), they give some first useful information for the discussion of the causal mechanisms mentioned above.

3. Results

The following tab shows the data I obtained from our survey and secondary sources:

Table 1. Access permits issued and ABS agreements concluded.

	Access Permits Granted		ABS Agreements Concluded		Commercial ABS Agreements/Year
	Commercial	Non-Commercial	Commercial	Non-Commercial	
<i>States Parties to the Nagoya Protocol with ABS Legislation in Force</i>					
India (2006–2016)		91 (53 since Party to the NP)	14 (2 under NP)	0	1.4
Guyana (2000–2014)		344		0	0
Cuba (2008–2016)		200	5	0	0.6
Peru (2009–2013)		180	0	10	2.5
South Africa (2008–2015)		17	33	n.i	4.7
Indonesia (2000–2015)		5286	n.i	n.i	n.i
<i>States Parties to the Nagoya Protocol</i>					
18 other state parties ¹		0	0	0	0
<i>States Parties to the CBD with ABS Legislation in Force</i>					
Costa Rica (2004–2015)	50	333	3	45	0.2
Ecuador (2011–2016)		n.i	1	39	0.2
Venezuela (1996–2016)		39	22 (13 since the current ABS law entered into force in 2009)	57 (27 since the current ABS law entered into force in 2009)	1.1
Brazil (2004–2013)	n.i	1057 (2010–2012)	103	n.i	11.4
Bolivia (2000–2005)		n.i	2 (50–60 requests)	8	0.4
Colombia (2003–2013)		n.i	1	89 (199 requests)	0.1
Mexico (1996–2011)		4283	n.i	n.i	n.i
Australia (2006–2015)	3	276	3		n.i

¹ Bhutan, Burundi, Cambodia, Comoros, Croatia, Czech Republic, Ivory Coast, the European Union, Finland, Germany, Norway, Rwanda, Slovakia, Spain, Switzerland, Togo, and UK.

3.1. Analysis of the Results

3.1.1. Accuracy of the Estimation

Considering the relatively poor response rate to our survey, I first of all have to acknowledge that our estimation of the number of access permits issued and ABS agreements concluded is not as accurate as expected. There are 39 countries with a functioning ABS legislation and I obtained data from 14 of them (35.8%). Among these 14 countries, 5 answered to the survey (India, Guyana, Costa Rica, Venezuela and Ecuador), and 9 either published the relevant data or answered to previous scholars [4,15,27,39,40].

Nevertheless, I cover a high proportion of the concerned megadiverse countries except China and the Philippines. Therefore, I can reasonably consider that, except the two countries mentioned, it is unlikely that I missed an additional State Party with an ABS legislation in force and with an important amount of permits and agreements.

3.1.2. General Comments

On the basis of the numbers at our disposal, it is clear that very few ABS agreements have been concluded so far. Between 1996 and 2015, 217 such agreements for commercial research and 248 for non-commercial research have been concluded. On average, out of the 14 countries with an ABS legislation in force, 2.05 ABS agreements for commercial researches have been concluded per year. Those results confirm therefore the consensus I found in the literature.

Regarding the implementation of national ABS legislations, I observe a significantly more important ratio of countries with such a legislation currently into force among the States Parties to the NP compared with the States Parties to the CBD only. That confirms the intuitive reasoning according to which there is a less important will among the latter to adopt a functioning ABS framework. In addition, with the notable exception of Switzerland, all the other 38 States Parties having an ABS law into force belong to the category of provider States. Those countries include 12 out of the 17 megadiverse countries. Out of the current 20 members of the Like-Minded Megadiverse Countries organization, 14 are States Parties to CBD and NP or NP only, with an ABS legislation into force. Those 14 GLMMC members represent 35.9% of the 39 States Parties having successfully implemented an ABS legislation. Therefore, it has to be pointed out that a significant number of the existing ABS legislations have been elaborated and adopted by countries known for their restrictive position on ABS. That also confirms the strong will of this group to regulate the access to their GR.

3.1.3. Analysis of the First Explanatory Causal Mechanism in the Light of the Results

Unsurprisingly, all the States Parties to the NP without an operating ABS legislation that have answered to our survey indicated that neither permits have been issued nor ABS agreements concluded as no legal basis has been established so far. This indicates, in accordance with the first explanatory causal mechanism, that the lack of ABS legislations could explain the poor results of the regime in terms of permits and agreements. This proposition is of course rather trivial.

In regards to the explanation relying on the attributes of existing ABS legislations, the results do not support any interpretation of the corresponding causal claims. Only an in-depth analysis of the relevant ABS legislations would enable to evaluate the efficiency and legal certainty of their procedures. Only then would it be possible to verify if clearer and more certain procedures would produce better results in terms of permits and agreements. However, I can mention that, on one hand some of these national ABS frameworks are already relatively old (more than 10 years for Brazil, Costa Rica, Cuba, India, Mexico, and the members of the Andean community and more than 8 years for South Africa) and that several have already been evaluated and improved [27,35]. Most of the existing ABS legislations provide for legal certainty, clarity, and transparency of domestic requirements as well as non-arbitrary rules and procedures for accessing to GR [35]. On the other hand, in practice, procedures to obtain PIC and MAT are generally not precisely described [35]. In addition, 11 out of the 14 States Parties with

an ABS legislation I obtained data about are GLMMC members, a stakeholder's group known for its nationalist and restrictive positions on ABS. Actually, several of the corresponding ABS frameworks (Brazil, Indonesia, and Colombia) have already been evaluated as restrictive, cumbersome, and finally dissuading the potential users [4,35] while the Costa Rican one has been considered as more clear, certain, and flexible [4,35]. Based on our results, it appears Costa Rica has so far concluded a relatively important number of ABS agreements (although the majority for non-commercial purpose) and as well as 383 access permits. That could indicate that the legal certainty and the facilitation of the ABS procedures could produce better results in terms of permits and agreements.

3.1.4. Analysis of the Second Explanatory Causal Mechanism in the Light of the Results

According to the results, users of GRs whether for commercial or non-commercial research activities, seem to have been relatively uninterested in GR bioprospecting for GRs in provider countries. Here again, based strictly on the obtained numbers, it is unclear whether this lack of interest is primarily due to complicated and uncertain legal frameworks (that users prefer to avoid dealing with) or, if it is to research strategies which do not require natural in situ GR.

It deserves to be noted that the results include almost all of the most biodiverse countries. According to the ranking produced by Mongabay (<https://news.mongabay.com/2016/05/top-10-biodiverse-countries/>), out of the 13 most biodiverse countries in the world, 11 appear in our results. As the potentially most important provider countries have so far concluded few agreements although they have implemented ABS legislations for several years (and even if those legislations suffer from weaknesses and can reasonably be considered as rather restrictive (see Section 3.1.2), the importance of their GR for the biotechnology industry can be put into serious question.

Our results also show that there is a relatively high number of access permits issued in comparison with the agreements concluded but more importantly, a significantly higher proportion of issued permits and concluded agreements for non-commercial purposes compared with commercial ones. This suggests that the private sector indeed showed little interest in prospecting GRs compared with basic research. It therefore would be relevant to pursue in the assessment of the hypothesis that the ABS regime implemented through the CBD and its protocol does not reach the actors of private research (those who are supposed to engage in research activities for commercial purposes) in the field of biotechnology, which is its main target group. As mentioned in Section 2.2, these actors have access to as many GRs as they need without engaging in the ABS process because they either have access to their own in or ex situ collections or can rely on alternative research techniques (bioinformatics, combinatorial chemistry combined with high throughput screening, etc.). On the contrary, actors from the public research, who cannot easily 'escape' from the ABS regime by using their own GR or by adopting alternative research strategies see therefore their activities more regulated by the regime. Several researchers working in public entities expressed a feeling of being overregulated and hindered from performing traditional and frequent tasks like requesting or sampling GR or exchanging them. This was also confirmed during the interviews I conducted.

3.2. Research Perspectives

This contribution shows some promising possibilities for further research. For example, after conducting an in-depth analysis of the content of two national ABS legislations, one considered as facilitating the ABS and the corresponding procedures and the other as restrictive and cumbersome for the potential users, to collect data on the agreements concluded under these legislations. Such research would certainly enlighten the impact of the ABS legislations provisions on the functioning of the regime. Another promising research perspective would be going deeper into the analysis of the (few) ABS agreements concluded so far. Such a qualitative analysis could shed light on the characteristics of the users of GRs (private or public research). Additionally, collecting data on the commercial utilizations of GRs (in particular on the corresponding patents and products placed on the market) would be necessary to determine to what extent the assumed relative disinterest for natural

GRs is real or if the utilizations of genetic material remains important but evolved in such a way that the CBD-NP ABS regime is not adapted to regulate them.

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