INTELLECTUAL PROPERTY OF AGRICULTURAL RESOURCES AND BIODIVERSITY

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The Impact of Intellectual property on biodiversity

Intellectual property is only a (small) part of a global process of biodiversity erosion. It is somehow the emerged part of the iceberg which concentrates all the criticisms. It is one element of **the progressive emergence of a professional breeding sector separated from farming activities** which has enabled huge yield increases but is also a source of biodiversity erosion.

The most fundamental and oldest drivers of biodiversity erosion are (1) land conversion and (2) specialisation on a few high-yielding species and varieties. If biodiversity renders important benefits to human societies it must however be said that throughout history the depletion of biodiversity has also generated important benefits for human societies. Indeed, one of the fundamental ways of human development has been **the conversion** of the naturally existing forms of assets to other forms, more highly valued by humans. Over the past ten thousand years, human societies have reallocated base resources towards a very small selection of species. These are the domesticated and cultivated varieties that have been developed for use in agriculture. Thus, through this conversion process, human societies and their associated species have expanded while reducing the resources available to other species.[1] Therefore, the human development process has been closely related with diversity decline over the past ten thousand years.

[1] Timothy M. Swanson (1997), *Global Action for Biodiversity…*, p. 11. See also R. Solow (1974), "The Economics of Resources or the Resources of Economics", 64 AMERICAN ECONOMIC REVIEW, 1-12

Table 1: Increasing Pressures on the Land

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

(developed)			
World (total)	1 345 461	1 511 330	12.3

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

Source: FAO[2]

This conversion process is moreover completed by a similar process within agriculture where a problem of genetic erosion in agricultural species and varieties is also observed. Within agriculture, the differences that have always existed among traditional agricultural practices are being replaced everywhere by identical modern intensive agricultural practices. Thus, not only human societies and their associated species have developed at the expense of other species but also within the human niche, **the agricultural activity relies increasingly on a diminishing number of species and varieties.** So, while thousands of plant species are edible and convenient for human consumption, the majority of the world food is provided by about twenty plant species, and among them the four biggest crops (wheat, rice, maize and potato) take the lion's share. The same is true for animal species where a handful of species (sheep, cattle, goats, pigs) provide the quasi totality of the terrestrial source-protein. A similar phenomenon even occurs within species where one can observed a **specialisation** on a few high-yield varieties.[3]

Table 2: The Extent of Genetic Uniformity in Selected Crops

[2] FAO (1998), *Agricultural Land Use,* Rome: FAO

[3] Timothy M. Swanson (1997), *Global Action for Biodiversity…,* p. 52

Crop	Country	Number of varieties
Rice	Sri Lanka	From 2,000varieties in 1959 to less than 100 today(1992), 75% descend from a common stock
Rice	Bangladesh	62% varieties descend from a common stock
Rice	Indonesia	74% varieties descend from a common stock
Wheat	USA	50% of crop in 9 varieties
Potato	USA	75% of crop in 4 varieties
Soybeans	USA	50% of crop in 6 varieties

Source: World Conservation Monitoring Center 1992[4]

Why such a specialisation? The answer lies in species-specific learning. To put it simply, progress in agriculture comes from three main factors: tools, chemicals and species-specific learning. With an increasing understanding of the biological nature of a species and of the possibility to influence it, it is possible to increase the production. So in a broad outline, when through time a group of cultivators have developed knowledge on one species, it is easier for other groups to adopt that species taking advantage of this already existing knowledge rather than constructing equivalent knowledge for other species. Because of the cumulative and non-rival nature of knowledge and as exchanges between different human societies increase, the food production is more and more concentrated on a few species.[5]

The erosion of the agro-biodiversity, particularly the specialisation of agriculture in a few high yielding species and varieties, is related with **the emergence of a professional**

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

[5] Timothy M. Swanson (1997), *Global Action for Biodiversity…,* p. 53-54

breeding sector which has had three important consequences: (1) the establishment of market authorisation procedure, (2) a demand for intellectual property right as an incentive for breeding innovation and (3) reduction of informal seeds exchanges between farmers.

Indeed, at the end of the 19th and above all in the beginning of the 20th century, the development of genetics and the general trends towards a growing division of tasks lead to the creation of a professional breeding sector autonomous from farming activities. The apparition of this new economic sector arouses a demand of legal supervision[6].

The first aspect of this legal supervision concerns the protection of farmers, i.e. seeds users. The latter are not any more the producers of their seeds and as seeds quality can only be assessed after the harvest, they need some information on their quality and protection against tricksters. This will lead to the establishment of a **system of market authorisation**[7] and catalogues of varieties. For example France and Germany at the end of the 19th and beginning of the 20th century set up catalogues of varieties and set up agricultural stations to monitor the quality of seeds, their homogeneity and their correspondence to their denomination. The creation of catalogues of varieties leads to a clearer legal definition of a variety. It is admitted that to be legally considered as a variety, a group of individuals must be very similar and clearly distinct from close varieties' individuals; thus a variety must be distinct and homogenous (uniform), and in the case of agriculture, value for cultivation and use. Similarly, to remain in the catalogue, a variety must be stable over the generations; the contrary would be cumbersome for farmers and would hinder breeders' work.

The second aspect concerns ***ex ante* incentives for innovations in plant breeding (IPRs).** Indeed, plant breeders need a device to obtain a return on their investment: because(1) the breeding activity has become an autonomous economical sector, because (2) the creation of new varieties is a long and costly process[8], and because (3) new plant varieties can readily be copied by free riders (farmers or rival breeders). After some attempts to protect plant

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

[7] Sometimes also referred as National Seed Certification Schemes

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

varieties by trademarks and patents[9], *a sui generis* plant variety protection right (PVP) is set up in the 1960s with the UPOV Convention. It protects varieties which are new, distinct, and uniform and stable (i.e. exactly the same criteria as those required to be registered in the catalogues of varieties). With the development of modern biotechnologies and new techniques such transgenesis (direct gene transfer), plant breeders have an interest in legally protecting genes and gene complexes themselves, rather than the finished crop varieties. This leads to a progressive admission and generalisation of the patenting of plants since the 1980s.

Do seed regulations have a negative effect on genetic diversity?

It has been claimed the requirements for **market authorisation**[10] i.e. distinctiveness, uniformity and stability (DUS) and in the case of agriculture, value for cultivation and use, have had negative impact on biodiversity in the sense that they prevented the production and marketing of landraces[11] and varieties which are naturally adapted to local and regional conditions but do not comply with the requirements, especially the uniformity condition. In Europe, this matter is regulated by two Council directives[12] and to cope with this issue, the Commission introduced in 2008 certain derogations for the acceptance of these landraces and locally adapted varieties threatened by genetic erosion.[13]

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[9] See Mark D. Janis & Jay P. Kesan (2002), "U.S. Plant Variety Protection: Sound and Fury…?", 39 HOUSTON LAW REVIEW 727, p. 731 See also Nicolas Brahy (2008), *The Property Regime of Biodiversity and Traditional Knowledge, Institutions for Conservation and Innovation,* Brussels, Larcier, pp. 160-195

[10] For a detailed analysis of seeds regulations and their impact on biodiversity see Shabnam Anvar (2008) *Semences et Droit, L'emprise d'un modèle économique dominant sur une règlementation sectorielle*, thèse de droit Université de Paris I Panthéon-Sorbonne.

[11] Landrace refers to domesticated plants adapted to the natural and cultural environment in which they live (or originated). They often develop naturally with minimal assistance or guidance from humans using traditional breeding methods. They are grown from seeds which have not been systematically selected and marketed by seed companies or developed by plant breeders. Landraces will refer to all those cultigens that are highly heterogeneous, but with enough characteristics in common to permit their recognition as a group. This will include all cultigens cultivated without any specific nomenclature and value. A landrace identified with a unique feature and selected for uniformity over a period of time for maintenance of the characteristic features of the population can evolve into a farmers' variety or even a modern cultivar as in many crops (**http://en.wikipedia.org/wiki/Landrace** last visited 15 April 2009)

[12] Council Directive 2002/55/EC of 13 June 2002 on the marketing of vegetable seed, Official Journal L 193, 20/07/2002 p. 33 – 59 and Council Directive 2002/53/EC of 13 June 2002 on the common catalogue of varieties of agricultural plant species, Official Journal L 193, 20/07/2002 p. 1 – 11, Corrigendum (L284 - 27.10.05, p.10)

[13] Commission Directive 2008/62/EC of 20 June 2008 providing for certain derogations for acceptance of agricultural landraces and varieties which are naturally adapted to the local and regional conditions and

Similarly, the requirements for protection by the **plant variety protection right (UPOV)**, and particularly the uniformity requirement have been criticised for creating "perverse incentives" Indeed in rewarding only the breeding of uniform varieties, the PVP right does not allow for the protection of plant groupings with a high degree of diversity as is typical of many "landraces", thus depriving their breeders of potential benefits.[14]

As to the requirements for protection of a plant by a **patent,** it is difficult to assess whether they have an impact on genetic diversity and I am not aware of any study dedicated to this issue. A question that might be worth exploring is whether patentability requirements do reinforce the continued focus of bio-industries on monogenetic, absolute resistance to the detriment of polygenetic resistance which fundamental scientific regard as generally more durable and favourable to the maintenance of biodiversity.

Has intellectual property an impact on informal seeds exchanges between farmers?

To answer this question, it must be also recalled that the intellectual property is only one aspect of a broader issue which is the emergence a specific professional breeding sector separate from farming activities and later the growing concentration of this sector.

The consequence of the existence of a specific professional breeding sector is that, at least in modern agricultures, most of the breeding innovation is no longer made by farmers. Farmers do no longer invent new varieties but rather buy them from seeds companies. Farmers continue to some extent to re-sow part of their harvest and/or to exchange seeds with other farmers[15] but this practice is limited by the need to renew the varieties regularly as their resistance does not last more than a few years (see below). The situation might be slightly

threatened by genetic erosion and for marketing of seed and seed potatoes of those landraces and varieties Official Journal 162, 21.6.2008, p. 13–19

[14] OECD (1996) *Saving Biological Diversity: Economic Incentives*. Paris and Dan Leskien and Michael Flitner, (1997), "Intellectual Property Rights and Plant Genetic Resources: Options for a Sui Generis System", ISSUES IN GENETIC RESOURCES No. 6

[15] A study by Rabobank gives the following estimation on farm-saved seed of small grain cereals in the EU in 1994: Germany (50% of total seed demand), France (50%), Italy (70%), Netherlands (20-25%), Denmark (5%), Ireland (20%), UK (30%), Greece (90%), Spain (90%), Belgium (35%). See Rabobank (1994), *The World Seed Market: Developments and Strategy,* Agricultural Economic Institute (LEI-DLO)/Rabobank/Ministry of Agriculture, Nature Management and Fisheries, Netherlands

different in developing countries and traditional agriculture where farmers buy new seeds less often; there is less renewal in varieties. Innovation is more limited and still occurs (for a part) among farmers. Therefore seeds exchanges are more important.

It is in this general context that one must examine **the specific impact of IPRs on seeds exchanges.** The situation varies according to the type of IPR (PVP or patent) and the countries.

In the earlier versions of the UPOV Convention, including the 1978 version, in vigour in a number of countries, re-sowing and seeds exchanges (the so-called Farmer privilege) were implicitly allowed. In the 1991, (1) the farmer privilege is for the first time mentioned explicitly but simultaneously (2) it becomes optional in the sense that the member states are free to introduce it or not in their legislation and (3) it is limited, i.e. it must remain *within reasonable limits and [is] subject to the safeguarding of the legitimate interests of the breeder.*

As the farmer's privilege has become optional, the situation varies according to the choice made by UPOV member states. In the European Union, the matter of plant variety right is ruled by the Council Regulation No 2100/94 of 27 July 1994 on Community Plant Varieties Rights[16] (hereafter the basic regulation),which includes the farmer's privilege. The basic regulation authorizes farmers to use their harvest as seed sources under limited conditions as set forth in the UPOV Convention: they can only use the harvest that they have obtained on their own holdings and only for their own use. Regarding the 1991 UPOV convention requirement to safeguard the *legitimate interests of the breeder*, the basic regulation draws a distinction between small farmers and other farmers. The former category may freely re-sow their harvest while the latter group is required to pay an equitable remuneration to the holder of the plant variety protection right. In the USA, the situation is different. Until 1994, the Plant Variety Protection Act allowed farmers to save and re-sell part of their harvest as seeds. In 1994, the Congress suppressed this provision which led to a judicial conflict and a decision of the Supreme Court which limits the farmer privilege to a right to re-sow in the farmer own land.

As to the impact of patent law, it normally does not include an exception similar to the farmer's privilege. Therefore, a farmer is not allowed to re-sow patented varieties. The situation is different in Europe as the Directive 1998/44 on the Protection of Biotechnological Inventions established within EU patent law a farmer's privilege identical to the one existing in the plant variety protection right.

How to measure the impact of Intellectual property on biodiversity ?

Honestly, I doubt that it could be measured in a reliable way. Firstly, as explained above, intellectual property is only one element of a larger process of specialisation of agriculture in a small numbers of species and varieties and the creation of a specific seeds sector and it concentration. It would be difficult to isolate the specific effect of IPRs. Secondly, so far the empirical studies on the effect of patents on innovation (their objective) do not (yet) succeed in giving clear, stable and consistent results. It is even less likely that they could provide such results on the impact of patents on biodiversity.

Why is biodiversity a source of resilience for farmers?

One important benefit provided by biodiversity lies in its information value; in other words its role as input into the research and development (R&D) process in industries concerned with the regulation of biosphere (e.g. pharmaceutical and agricultural industries). These “bio-industries” can be conceived as defence systems or dynamic contests between human societies and nature. A bit like Sisyphus’ work, these industries consist of relentless efforts to struggle against the erosion of human erected defence against a hostile biological world.[17] In agriculture, we perpetually renew a system that faces the always-evolving pests and predators of our food crops.[18] For instance, in the agricultural sector, the development of a new variety usually takes about 10 years while the developed resistance characteristic is

[16] Council Regulation (EC) No 2100/94 of 27 July 1994 on Community plant variety rights (OJ L 227 of 01.09.94 p. 1)

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

[18] *Ibidem*, p. 13

often viable only for 4 or 5 five years. Therefore, a continual breeding effort for new resistance is essential.[19]

Biodiversity is an essential ingredient in the defence of the human domain because it contains relevant information. The same forces which are operating against the human domain are also at work against other living organisms. Any life form which survives has developed resistances that are successful in a contested environment. It is for the retention of these existing strategies of resistance that human societies need biodiversity. In certain cases, biodiversity provides a sort of alternative to R&D process. For instance, in the identification and use of medicinal plant, biodiversity provides a solution that is already known to answer a problem. More often, the information provided by biodiversity can be seen as a raw informational input in the pharmaceutical and agricultural industries.[20] Thus, primary value of biodiversity lies in its informational content and its utility in the R&D process of those industries.[21] The notion of R&D can be seen as a production process dependent of a stock of information for the generation of useful innovations, i.e. solutions to economical problems faced by society.[22] In bio-industries, biodiversity is precisely one of these stocks of information.

Technically, the seed industry observes the genotype (i.e. the nature of the genes possessed by the individual whether they are expressed or not), identify interesting traits and attempt to transport it to a closely related organism through breeding. For long, this has been the quasi-exclusive strategy pursued by agricultural industries. With such a strategy the interesting information is transported between near relatives using actual genetic material. Recently, the important progresses of biotechnologies have diminished the technical constraints in the transferability of biodiversity's information which increases the usefulness and thus the value of that information.[23]

To what extent do bio-industries rely upon biodiversity? Out of a study carried out in the agricultural industry, it appears that the sources of useful biological information range

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

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

[21] Timothy M. Swanson (1996), "The Reliance of Northern Economies …", p. 3

[22] *Ibidem*, p. 4

[23] *Ibidem*, p. 4

from the already exploited cultivars to completely wild species. Each year, around 6.5% of the successful genetic research resulting in a marketed innovation comes from germplasm of unknown species while 82% comes from already exploited cultivar. It indicates that every year, the R&D system requires an injection of 7% new (existing in the nature but unknown hitherto) genetic material. In other words, the stock of information in the agricultural R&D has a depreciation rate of 7% and must be renewed at that rate.[24]

In addition to this information value, biodiversity has also an insurance value. All biological resources are productive assets in the sense that they grow and reproduce. Having at one's disposal a large set or productive asset provides an insurance service known as the portfolio effect. That is to say that if varieties have unpredictable elements in their yield, the rate of return of a package combining a large number of different varieties will have a reduced variance relative to the variances of individual variety as their yield variability cancel each other.[25] And indeed, one can observe a correlation between conversion to specialized and uniform varieties on one hand and increased variability in productivity on the other hand.[26] Therefore, variability in productivity increases when most cultivators of a region use the same crops as the results of all producers move together. So, for instance if one year, the weather conditions are favourable to that crops, it is favourable to all producers and vice-versa. It is a typical example of the lost of the portfolio effect. Another example, causing less frequent but more serious damage, is the increase in genetic uniformity within a species. The genetic variety of a given crop is an important element of its resistance to pests. Thus, the genetic diversity within a species provides insurance against external shocks such as pests, diseases, droughts, etc. A tragic example of an absence of portfolio effect can be seen in the Irish Famine of 1846. The potato originally comes from South America and was introduced in Europe in the post-Columbian exchange of species. Potatoes were introduced to Ireland in the 18th century where it became crucial to feed the poor. It is estimated that the population tripled to 8 millions thanks to this cheap and plentiful crop.[27] However, the potatoes introduced consisted only of a small number of varieties and in 1846 when an unknown

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[24] See Swanson T.M. & R.A. Luxmore (1997), *Industrial Reliance on Biodiversity…*, 98 p.

[25] To the extent that the unpredictable elements in the different varieties yield are different and uncorrelated)

[26] See D. Duvick (1989), « Variability in U.S. Maize Yields », in J. Anderson and P. Hazell (eds)*Variability in Grain Yields*, Washington D.C: World Bank or P. Hazell (1984), "Sources of Increased Variability in Indian and US Cereal Production" AMERICAN JOURNAL OF AGRICULTURAL ECONOMICS, 66

[27] H. Garrison Wilkes (1988), "Plant Genetic Resources over Ten Thousand Years : From a handful of Seed to the Crop-Specific Mega-Gene Banks", in Jack R. Kloppenburg Jr. (ed.) *Seeds and Sovereignty, the Use and Control of Plant Genetic Resources*

disease caused by the *fungus phutophtora infestans* attacked, half of the crop was lost, two millions Irish died, two million more emigrated and much of the remaining population went back to deep poverty.[28]Obviously, today, farmers have technological answers to the attacks of nature. However, even in the age of pesticides, herbicides and fertilizer, pathogens might be able to exploit the specific inherited from common parent lines. For example, in 1970 the "The Southern corn leaf blight" decimated the corn yield in the U.S. Although the pest was only dangerous for a few forms of maize, it cut production of the essential food by 15 percent because ninety percent of corn crop cultivated in the U.S shared genetic material from the same parent line.[29]

Biodiversity also provides other values such as ecosystems services, recreational values or bequest value but they are less directly relevant for farmers. [30]

Can the Convention on Biological Diversity counteract the negative impacts of intellectual property on biodiversity?

The text of the Convention is unlikely to counteract any extension of IP. On the contrary, the Convention takes note of the growing patenting of "worked" genetic resources and establishes a national sovereignty on "raw" genetic resources. This can interpreted as a kind of compensation or as further extension of ownership on genetic resources. However the adoption of the Convention and the international discussions on the access to genetic resources and benefit sharing have certainly increased the awareness of biodiverse countries about the value of their biodiversity and the need to slow down its rapid erosion.

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

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

[30] For a detailed analysis of the different values of Biodiversity see OECD (2002), *Handbook of Biodiversity Valuation : A Guide for Policy Makers* and OECD (1999) *Handbook of Incentive Measures for Biodiversity: Design and Implementation,* Paris: OECD

Is the recognition of an intellectual property right for the biodiversity-rich countries on their resources, able to preserve biodiversity?

The recognition of a national sovereignty on biodiversity can be explained in two ways

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

Academic circles came to the same conclusion through theoretical reasoning. The theory of property rights developed by Ronald Coase[31] predicts that problems of externalities and public goods can be solved by the creation of property rights when transaction costs are low. The conservation of biodiversity appears to be a public good or at least a source of positive externalities: biodiversity is not only useful for their holders but also for the international community because they are useful sources of information for bio-industry. If countries rich in biodiversity cannot capture the benefits of conserving biodiversity and traditional knowledge, they will under-invest in conservation, and destroy biodiversity by turning land where it lies to more immediately productive uses. One possible solution lies in the creation of property rights that enable holders of genetic resources to internalize the benefits of conservation.

As a result, the Convention on Biological Diversity confirms the patentability of biotechnological innovations and invests states with national sovereignty over their genetic resources and to some extent invests local and indigenous communities with a property right to their traditional knowledge. In so doing, the Convention encourages the negotiation of

[31] Ronald Coase (1960), "The Problem of Social Cost", 3 JOURNAL OF LAW AND ECONOMICS 1

bioprospecting contracts by which bio-industries could obtain access to genetic resources and knowledge from biodiverse countries and TK holders. In the situation where innovations were developed or derived from these genetic resources or traditional knowledge, the contracts would provide for the sharing of benefits. The potential for such compensation is supposed to encourage biodiverse countries and TK holders to conserve their biodiversity and knowledge.

More than fifteen years after the entry into force of the Convention, the outcome is disappointing. It turns out that the creation of property rights has not generated sufficient benefits to fund the conservation of biodiversity. In addition, it seems that this mechanism seriously hinders bio-industries' access to genetic resources.

The ongoing negotiation of an international regime access and benefit sharing may slightly improve the situation but it is unlikely to make a big change.

As to the International Treaty on Plant Genetic Resources which sets up a multilateral system of facilitated access for a subset of genetic resources, one can expect that it will improve the access of bio-industries to genetic resources and it is too early to judge its capacity to fund the conservation of biodiversity.