Biodiversity Management:
Intellectual Property Rights and Farmer's Rights.

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Stream: Global Themes - Intellectual Property Rights

Traditional plant varieties and wild species are disappearing irreversibly, and this process has resulted in the disappearance of farming know-how and the genetic information it entailed. 'These varieties have been replaced by modern ones, which are economically more efficient but which have only a low degree of genetic diversity. What will happen if, for example, these modern varieties turn out to be ill-adapted, or if a pathogen appears? Given the reduction of biodiversity and the risks involved, it is necessary to preserve: preservation for the present generations, in private banks where the preserved material is, or will be, used in plant breeding programming, (the economic aspect of preservation); preservation for future generations, by developing an analysis in social terms of the intergenerational models and of sustainable development.

Preservation efforts can only be carried out in the countries of the South where biodiversity is a reality. In general, it is the same countries that are dependent on Northern technology for their plant improvement programs. Conservation has a cost which is borne by local populations but which is rarely taken into account in the evaluation of indicators for conservation choices. The reduction of conservation costs for local populations is one of the key challenges for the preservation of biodiversity. On a scientific level, the aim is thus to define, evaluate and incorporate the interactions between populations and biodiversity in the estimation of biodiversity. The projects of development have to conciliate an approach in terms of sustainable development for the local communities ("sustainable development is a development that replies to current generation needs without limiting capacities of generations to reply to their needs") with a precautionary principle for the Biodiversity ("in case of serious or irreversible threats on the environment, a scientific certainty lack does not have to be a pretext to give until later the adoption of efficient measures aiming to warn environmental degradations"). In this paper there are two goals : to evaluate the benefits or advantages of a project integrating sustainable management of Biodiversity at each level of intervention in the decision (local, national, global) and to define property rights on the genetic resources.

1. The value of Biodiversity

Biodiversity, including local cultivars, wild species and various ecotypes, is therefore important from both an economic and a social point of view:

- in the short- and medium-term its economic importance lies in the creation of plant varieties in the North (high-yield varieties), but also in the South where local varieties must be improved through the introduction of yield characteristics which are well known in the North, rather than by the adaptation of Northern varieties to the South.

- its social importance resides in the moral necessity of not leaving a run-down heritage (in terms of biodiversity) for future generations. 'This can only be achieved through

preservation efforts. 'Isolated' ex situ preservation (a form of static preservation) is likely to be ineffective in the long term, given the evolution of the environment. In situ preservation must therefore also be promoted.

Since there is demand for agricultural land conversion, in developing countries especially, the Convention on Biological Diversity aims to establish conservation incentives but also to promote biodiversity and to implement mechanisms for sharing the benefits of conservation, in parallel with the definition of sustainability criteria. The creation of markets and the evaluation of biodiversity values are included in the standard economic analysis of resource management as indicators to assist decision making when conservation is in competition with other types of land use (agricultural, etc.). But, never forget that biodiversity in itself constitutes an indicator, measurable in the short term, of the quality of the environment or of the long-term evolution of ecosystems.

1.1. The values of biodiversity ?

One important characteristic of the natural heritage is the existence of opportunity costs related to the choice between incompatible activities and the competition between current and future uses :

* The current use value of biodiversity is based on two types of use, the direct consumption use and the utilization of Biodiversity as an input in production process. In this case, different studies proved that the development option taking into account Biodiversity is also economically sustainable (for example Ruitenbeek, in Victor P.A., Kay J.J., Ruitenbeek H.J., 1991) while other studies show that use value is very limited and is often insufficient to justify conservation (for example Mendelhson, 1994) [1].

* The non-current use value can be evaluated in terms of option value (maintaining flexibility against an uncertain future). The option value is linked, among other things, to the value of the information to be acquired on future uses.

* The non use value can be evaluated with the option price, the legacy value or the existence value (Willinger 1996).

To constitute effective aids to decision making, biodiversity indicators must of course be available and must incorporate ecological, socioeconomic and other criteria in order to evaluate and classify the ecosystems concerned.

* The ecological value of an ecosystem (Barbier et al. 1994) is linked to the ecological resilience. Perrings and alii 1992 argued : "When loss of Biodiversity reduces ecosystem resilience, its loss threatens the functions of the infrastructure of that system, and hence the ability to provide the range of ecological services needed for economic activity and human welfare.

In most cases, the reduction in the 'insurance value' of biodiversity that is currently taking place is not signaled in the price mechanism (Trommetter 1996). " In the selection of project of development, the definition and the calculus of those values are very important. The main difficulty is to make a hierarchy on the different projects. Indeed, at the local level the option

[1] For example, Norton-Griffiths and Southey (1995) evaluate the opportunity cost of biodiversity conservation in Kenya and show that the expected gains of conservation do not offset the opportunity cost of conservation in terms of development, a fact which calls for intervention on a global scale, represented in their approach by the GEF.

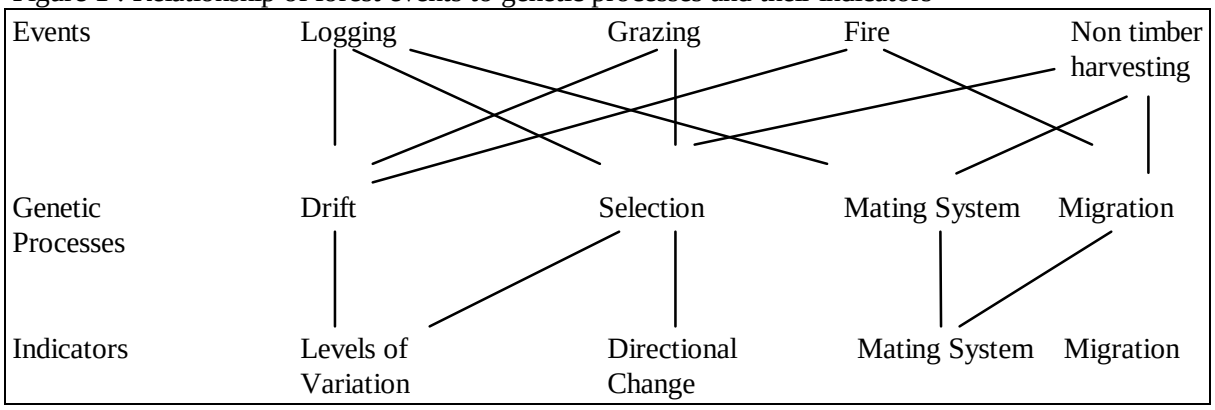
"not integrating the environmental constraint" the value is estimated in term of use value (court term approach) while at national and global levels the non use values and the ecological values are important and conduct the Global level to incite the local level to do differently (inter-generationnal equity). This approach to biodiversity may give rise to strong economic and social tensions. Biodiversity is rarely considered as a social object. A means must be found to reconcile conservation and development by involving local populations more closely in the decision-making process and by taking the interactions between "society" and biodiversity more fully into account.

1.2. *Biodiversity : a social object*

In the field of biodiversity conservation and management, the problem is to define a whole range of criteria simultaneously: what do we conserve ? what are the objectives of the conservation ? Who are the actors of the conservation ? who benefit from the conservation (possibility of conflicting uses, tourism, hunting, agriculture, etc.) ? , at what scale, what is meant by biodiversity, how should projects be classified, what types of indicator are required, and what is the opportunity cost of conservation in development terms ?

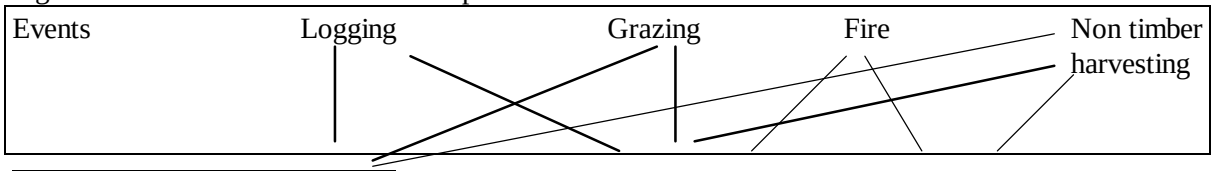
In 1998, Antona -Trommetter presented the difficulties to define interaction indicators. They conclude to the necessity to define indicators which have sufficient flexibility to integrate the various levels upon which biodiversity is perceived and to take account of uncertainty (of supply or demand) regarding the state of the future world and the irreversibility[2] of the decision to develop an ecosystem. There work is based on the work of Namkoong et alii 1997, who define the conservation of the broadest possible biological diversity as a prerequisite for maintaining the largest possible number of options for the future.

Figure 1 : Relationship of forest events to genetic processes and their indicators

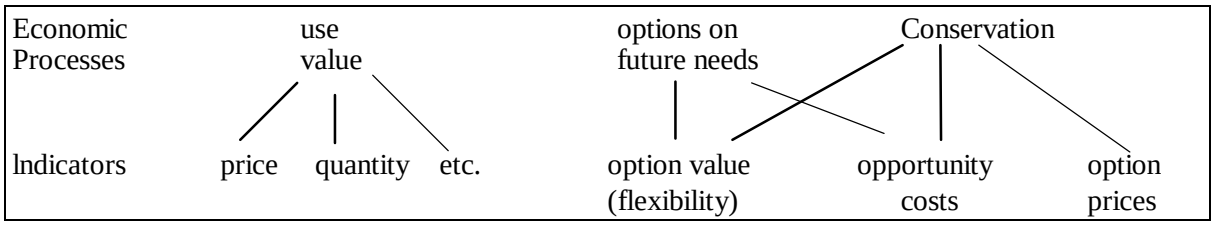


Source : Namkoong et al. 1996

Figure 2 : Forest events and economic processes and their indicators



[2] Acts considered to be irreversible rule out possible future choices, a fact which, in certain cases, may prove damaging to humanity. For example, the replacement of local cultivars by modern varieties and the degradation or destruction of certain sites are acts with irreversible consequences. We will examine this notion in more detail in part 2.



Source Antona - Trommetter 1998

These two tables reveal that the various events acting upon the forest have a non-neutral impact on genetic processes, but that at the same time, they have a positive use value, be they monetary or not (development, well-being, health, level of malnutrition, etc.). In a dynamic sustainable environment, the integration of future needs through identification of the options which will be available (increasing in number with the degree of diversity) is linked to the level of irreversibility (option value) of present uses with respect to future uses (opportunity cost of having taken an erroneous irreversible option

As in Lugo (1995), Antona - Trommetter point out that a natural and human disturbance threshold acceptable to the ecosystem must be determined. This ties up with the work of Namkoong et al. (1996) who state that genetic variability is a precondition for evolution and adaptation, i.e., that uncertainties and flexibility must be incorporated in developmental decision making and to the necessity to incorporate flexible biological criteria (non preference-based on ecological value) in the estimation of the option value to achieve consistency between economic and biological evaluations[3] of biodiversity.

2 . Institutional context and definition of property rights

With the uncertainties and the difficulties to define economic and ecological sustainable thresholds, there was some studies on the risks of non-conservation and the cost of inaction by the UNEP (1993). They conclude on the low profitability of conservation and the inadequate definition of property rights over biodiversity as the main causes of its depletion.

2.1. The introduction of property rights

Because the different development options may have different economic impacts, the decision maker has to check that there is inter- but also an intra-generational equity, which means that the agents who benefit from the environmental option should be the same as those who intervened at the local level (baseline of the project), otherwise, the sustainability of the environment project is not secured. This raises the question of the distribution of property rights over ecosystems.

We based our analyze on the typology of Schlager and Orstrom 1992 :

	Owner	Proprietor	Claimant	Authorized user	Unauthorized user
Access	×	×	×	×	×
Subtraction	×	×	×	×	

[3] For a presentation of biological models of biodiversity and resilience cf. Pearce 1997

Management	×	×	×		
Exclusion	×	×			
Alienation	×				

Source : Schlager and Orstrom 1992

Private rights.

Many authors (Farrow 1995, etc.) and organizations (OECD, etc.) state that private ownership is a prerequisite for the successful management of biodiversity, with common ownership leading solely to over-exploitation and the disappearance of ecosystems**.**

Positive example : in the case of Zimbabwe, Martin 1994 shows that in the case of the "park and wildlife act", through which landowners are entitled to make use of the wild flora and fauna, 500 commercial farmers gain all or a part of their income from wildlife management, with the land area reserved for wildlife increasing at an annual rate of 6%.

Negative example : Hasler (1994) uses the same example to demonstrate that « multiple jurisdictions in regard to wildlife and the ambiguity of overlapping rights between global controls, the state, the private sector and the community, and the competing rights and vested interests within each of these domains need to be taken into account when we talk about devolving proprietorship to the lowest accountable units ».

* ***Common property rights***

This approach is based on the attribution of exclusive usage rights to local communities through a contractual agreement between the state and local populations, the creation of a collective long-term management objective and the development of mechanisms for negotiation and collective action[4]. Generally, as Antona-Trommetter 1998 presented, in a common property the rights of populations are limited to the receipt of payments for conservative uses of biodiversity (ecotourism, pharmaceutical prospecting, etc.). Resources are shared and allocated via a negotiation process, with expert scientific know-how required only when a choice needs to be made between the various scenarios established during the negotiating process, and never beforehand (Weber, 1997). These contracts are currently being drawn up and as yet we do not have sufficient hindsight to analyze the consequences of this transfer of rights to local communities or the effect of this policy on biodiversity conservation.

* **Farmers' rights**

The Food and Agriculture Organization is planning try to set up an institutional system based on a multilateral mechanism for exchange of genetic resources and to create an international fund to compensate the countries of origin of the resources used. In this system, the seed

[4] As everybody knows, the tragedy of the commons presented by Garret Hardin exists only when there is no defining rights (free access without regulation).

production companies protect their plant varieties by means of a plant breeders rights[5] which protects the variety while guaranteeing a principle of open access to the genetic resources it contains. Parallely, the FAO is defining "farmers' rights" recognizing the work of domestication and improvement of local varieties by successive generations of farmers[6]. This concept, which seeks to identify an intellectual property right for resources, is more fragile than the other internationally recognized systems of protection (patents, brands, copyright). Indeed, it was initially conceived as a counterpart to the Plant breeders right. The FAO is attempting to concretize the concept via national legal provisions, though such provisions will remain limited as they grant no exclusivity to farmers.

The objective of these different institutional mechanisms is to define the conditions of access to Biodiversity that insures benefits sharing and Biodiversity preservation. The tendency is towards a mechanism of allocation of usage rights and land privatization associated with the creation of markets. In this context, there is no guarantee that local knowledge will be taken into account and the principle of allocation of rights does not safeguard the sustainability of biodiversity. How to be sure that local actors are the final recipients of these rights ? In the case of genetic resources, on the other hand (even though the texts have not yet been ratified), the trend is towards a system of benefit sharing which recognizes the role of local populations in the evolution, understanding and management of biodiversity. We will now developed this example.

2.2 The particular case of agricultural genetic resources

It is not possible to transpose the results obtained for pharmaceuticals to agricultural genetic resources for a number of reasons: (i) innovation is cumulative, in the sense that the genes of past innovations must often be combined with genes corresponding to future innovations; (ii) genetic variance is practically indispensable for genetic progress in agriculture; (iii) the final market is quite different: it is more segmented in agriculture where varieties are adapted to specific zones, whereas a pharmaceutical molecule can be used to treat an illness throughout the world. In agriculture research, the situation is paradoxical, because plant improvement, beneficial for humanity on a short/medium term, leads to uniformity of seeds, to gradual erosion of diversity (inter-specific and intra-specific), to the disappearance of the genetic pool of local cultivars and therefore to vulnerability of commercial varieties confronted with diseases and predators (Trommetter 1997). On the basis of studies of experts, R. and C. Prescott-Allen (1986) concluded that the annual contribution of wild genetic resources to American agriculture can be evaluated at $US 350 million (in 1980 dollars).

2.3.1. Evolution of the FAO agreements on genetic resources

[5] As stated by M. Glachant and F. Lévêque (1993:29), "this system protects varieties for a period of 15 years which thus defines the rights of their creators. It is an exclusive right over the material of reproduction or multiplication of the new variety: the creator's authorization is required for all forms of commercial production, marketing or sale of this material. This right may give rise to the granting of licences or simple transfer. The non-repeated use of such protected varieties for research is, on the other hand, totally open".

[6] .The balance chosen by the FAO - open access to resources and compensatory payments for farmers' collective rights via an international fund (financed by a tax on profits earned on genetic resources with facilitated access) - is typical of the common heritage status of humanity

In 1981, the FAO prepared an International Convention on Phytogenetic. In this forum, the FAO defends the notion of a common heritage and guarantees open access to genetic resources in their ecological niche. Parallely, for seeds, a Plant Breeder's Right[7] (PBR) guarantees variety protection but assures a principle of open access to genetic resources in the variety. In 1987, the FAO defined "farmers' rights" recognizing domestication and improvement of local varieties carried out by successive generations of farmers. An international forum was created for the discussion of related geopolitical issues particularly for these "farmer's rights,". The FAO also wished to create an international fund designed to support genetic resource conservation programs in Southern countries. Even if recognition of these "farmers rights" appears to be the preliminary step to establishing national sovereignty, the balance chosen by the FAO - open access to resources and compensating payments for collective "farmers' rights" drawn from an international fund - It could be analysed as a New définition of the Common Heritage status (NCH). The FAO's objective is to make it as a protocol of the Convention on Biological Diversity (1992). The institutional system proposed by the FAO would be based on paid open access to agricultural genetic resources at every level. In this framework the FAO redefines the basis of a Global System, to render it compatible with the Convention on Biological Diversity, and reaffirm the principle of a multilateral exchange system. The agreement, on the necessity to base the revision of the International Commitment on a such system, holds to these two elements :

- the logic of utilization of genetic resources is on the concentration of favorable character rather than on an alone character;

- bilateral transaction costs linked to this characteristic and to the economic structure of the sector are raised .

In these cases, the principle of an International Cooperation by a data and exchange Network integrating international banks (IRRI, etc.), national banks (Wagenningen etc .) and private selectors, seems adopted. A such system would have to allow to reply to a double objective : to limit costs of the conservation while maximizing stemming benefits of Genetic Resources.

However main two questions remain in abeyance : (1) what types of resources will constitute these collections (positive or negative species list, category of Genetic resources : related wild species, ancient varieties, etc .)?, (2) how does one define the access to these resources (totally open, open for the adherent to the system, deferred, with Material Transfer Agreements and benefits sharing, etc .)? This last question is complex because the evolution of property rights intellectual in the area of the alive remains uncertain. Joly & Trommetter (1994:340) proposed to set up a system of PBR or patents with dependent permits making it possible to preserve (remunerated) access to a resource with, at the same time, (remunerated) access in developing countries, either by users taxes or through an obligatory international fund, a system proposed now by the FAO.

2.3.2. Rationalization of preservation : incentive approach

We can highlighted certain criticisms of the various systems of preservation incentives :

[7] "The Plant Breeder's Right," write P.-B. Joly & M. Trommetter (1991:8), is very different from a patent since the monopoly is limited, from two points of view : the farmer's privilege; and any breeder can freely use a rival's plant varieties, although they may be under an exploitation monopoly. This is what is called Open Access to protected plant varieties as source of initial variability. If from an existing variety A he creates a new one B, he will be able to put B on the market freely, without the breeder of the variety A being able to oppose his own rights. This is an essential difference with the research exemption of the patent system."

* In a Purely private approach, we have the privatization of the resources by the South and a system of strong patents in the North. Such an approach can have disadvantages

* for the countries of South, which will then engage in fierce competition -with each other if they hold similar resources (relation between supply and demand);

* for the countries of the North, as it entails a lesser incentive to R&D, in particular if developing countries agree to block resources;

* in terms of the possibility of rapid paralysis of the system,

* in terms of what is left for future generations, because of the sheer uncertainty involved.

Thus, as it stands, it cannot be seen as a model for encouraging the preservation of biodiversity.

* in a New Common Heritage approach based solely on a compensation system of the users' fee type, There may be adverse effects on South-South relations[8].

* the alternative models, such as the 'debt for nature swap' or ‘cooperation incentive' system, can only be used on a case-by-case basis, and therefore provide no lasting solution to the problem of encouraging the preservation of ecosystems.

In view of these problems, it would seem that a only NCH system with paid access (payment being either in monetary terms or through transfer of technology) associated with a UPOV Plant Breeder Rights, or a patent system accompanied by dependency licenses, would be compatible as an international system for encouraging the preservation of biodiversity (Joly-Trommetter 1991). We will attempt to develop our analysis by showing that the combination of a compensation system, of the users' fee type, and an International Fund, would tend to lessen the financial burden for the state involved and thus would reduce their reluctance about flows of funding from North to South long-term vision of preservation). Thus, in our analyses of preservation incentives, we will distinguish between the procedures to be adopted according to the typology of biodiversity. One could envisage a compensation mechanism based on farmers' rights, or cooperation contracts, on a case-by-case basis, between Northern companies and countries of the South, concerning the preservation (and improvement) of local varieties. In this case, the problem of strong patents would be removed bringing us close to the NCH approach. At the same time a NCH approach could be adopted, with a compensation mechanism based on an International Fund, financed by the public authorities[9] or by a tax mechanism'. This would have the advantage of encouraging the preservation of ecosystems, while taking full account of the need to hand down the heritage to future generations. Such a situation being quite compatible with the NCH approach, it would be feasible to reestablish the notion of equity in South-South exchanges, replacing the users' fee by the activities of the international incentive fund.

2.3.3. The behavior of the actors in a cooperative system

[8] D.Wood 1988: 280. "the developing countries of Asia have a higher annual production of crops of latin American origin - $ 27 billion - than do the countries of latin America whose annual production of crops of indigenous origin is only $ 14 billion. Should the relatively poorer farmer of Asia pay the somewhat better off farmers of Latin America for the use of this germplasm?'

[9] The public authorities can set up a tax, in their respective countries, on the profits of the seed company, or introduce a tax on the price of seeds.

Until now we have focused on the limitations of the various preservation incentive systems. As far as, the privatization of the genetic heritage is concerned, if these limitations are not taken into account then there is a risk that the relations between agents will lead to a situation of cooperative behavior fraught with dangers between the countries of the South and the chemical (biotechnological) industries of the North. This situation seems to be hardly conducive to encouraging either the preservation of genetic resources in the South or R&D in the North. 'This is why we have opted for the NCH model with paid open access, which can be seen as a way of establishing cooperative behavior without danger, in which the maintenance of the status quo is less difficult.

Such behavior calls for the identification of a point of equilibrium, which, in the field that concerns us here, means :

* defining the mechanisms to be used: on what basis and to what degree of financial commitment will the countries of the North be willing to finance the preservation of the ecosystems in the South?

* defining the incentive systems, when there is asymmetrical access to information: how can one verify that the sums of money that are granted for that purpose are in fact used in conservation programs?

In this case, it would seem that the integration of the market within the framework of NCH leads to paid open access and that this is a strong preservation incentive. Such integration can be achieved by inviting tenders for the preservation of certain ecosystems, or by North-South cooperation models. We will be showing to what extent this program can be integrated into the NCH approach. We could say: with needs as the starting point, areas which are rich in genes are identified and classified in order to determine the size of the fee to be paid, as well as preservation requirements in their order of importance. In that case, negotiations on the amount of funds (in the International Fund) must be based on the evaluation of preservation costs, but also of the costs of the necessary transfers of technology between North and South. 'The point(s) of equilibrium will result from the cost/advantage analysis of the preservation of a certain number of species. * the asymmetry of information, if a too highly administered management of the fund is considered undesirable, leads to a system of tenders for preservation, or to North-South cooperation contracts, in which there is a market logic for the incentive, even though decisionmaking (on norms, prioritization) continues to he based on an 'administrative logic'.

The case of local varieties

In this case, as we have already mentioned, we are in favor of an incentive mechanism bared on farmers' rights, associated with cooperation contracts which would be strictly limited in time, given the short- to medium-term economic importance of these varieties. ***"What should be the characteristics of these cooperation contracts for them to remain consistent with the paid open access approach?***

The contract must envisage the payment of a tax, accompanied by a transfer of technology and maintenance for the South, whereas the Northern industrialize obtains 'exclusive development right.-,' on the discovered molecule. Such an incentive mechanism will only be compatible with the NCH approach with paid open access if international law is developed so as to accommodate paid open access. Indeed, although protection by patent is both strong and global ' unlike protection by strong patents on a particular application of the gene, the

cooperation contract enters into a purely private logic, in which the monopoly of exploitation covers all the applications resulting from' the gene. Such a system could have harmful consequences in the future, as we have pointed out throughout this paper, on North/South, North/North or South/South relations.

NCH cannot function without financial (or other) compensation. Since the asymmetry of information is likely to make administered incentives difficult to handle, a purely private approach to decision-making and incentives (strong patent.,;, entrance barriers) is not compatible with open access to resources. This is why we have suggested a market incentive combined with PBR, and a system of patents with which are either r-compulsory or limited to the particular application of the gene. 'This keeps us close to the market approach whilst conserving the notion of open access to resources and techniques, i.e. the most equitable situation for the South and for the non-biotechnological seed companies of the North.

Wild species

As far as wild species are concerned, incentives should preferably be organized through an International Fund. However, if such a body were funded by public money alone, this would not, in our opinion, be efficient, for several reasons:

* inter-State relations, because of the asymmetrical character of the information they possess, call for tightly administered funds;

* in the relations between States and economic agents, since the seed companies do not take into account preservation constraints in their behavior, there is a lack of interest for the long term and for future generations.

'The incentive to longer-term conservation must be oriented towards the preservation of the ecosystems of the South (through tenders) in order to offset the asymmetry of information, and towards an international State-financed fund, using a tax on seeds or ether farm and food products. This should oblige companies to pay more attention to the preservation of biodiversity in their programs, until these same companies finally - and voluntarily - take over part of the preservation effort themselves, not only in the short but also in the longer term. However, some evaluations minimize the potential value of genetic resources or prove inconclusive. Simpson et alii (1996) proved that the marginal value of a hectare of threatened habitat is negligible. The limits appear to be linked, in the case of non-ligneous forestry products, to the uncertainties concerning potential markets and, in the case of pharmaceutical products, to the existence of possible substitutes, the redundancy between species and their low marginal value (Brown, Goldstein, 1984). The use of genetic resources managed in-situ for pharmaceutical programs and the problems of benefit sharing are also developed by Swanson (OECD 1997). He highlights the fact that in the pharmaceutical industry, research based on natural products represents 5 to 20% of total R & D expenditure and that local knowledge of uses is often behind the development of new drugs. In agriculture, on the other hand, there is little in-situ use of wild or domesticated material as presented in table 2.

Table 2 : Source of germplasm by crop group (in per cent)

Source of Germplasm	**Potato**	**Cereals**	**Oil crops**	**Vegetables**
Commercial cultivar	50.0	87	78.8	95.7

Related minor crop *	8.0	0.6	1.2	0.3
Wild species - *ex situ* genebank	1.9	1.2	1.0	1.4
Wild species - maintained *in situ*	0.0	0.7	0.1	0.1
Landrace - *ex situ* gene bank	1.7	1.7	2.3	1.7
Landrace - maintained *in situ*	0.0	0.7	2.8	0.4
hiduced mutation	3.3	0.7	7.2	0.3
Biotechnology	17.7	3.5	6.8	0.1*

* minor crop cultivated on a small scale with some improvement over wild ancestors

Those results conduct the different authors to write : "we must be optimistic to think that the marginal value of a resource is high and that there exists a relationship between the probability to have a good gene and the marginal value. At the end the conclusion is that the marginal value of a hectare of a threatened habitat is negligible and so if the international community values biological diversity it should be actively seeking other alternatives for financing its conservation". The conservation should be viewed as a public policy problem.

Conclusion

The approach that we advocate thus has two aspects: one concerning local varieties and the other wild species. Its underlying logic is unambiguously that of the NCH approach (open but paid access associated with PBR or patents with dependency licenses). Intuitively (but such intuitions can be modeled) it can be seen that it is in the interests of the various actors to accept cooperation with a view to encouraging preservation (as we have defined this), i.e. it is in the interests of each of the actors when elaborating their strategy to take into account the others' strategies in order to arrive at an optimal situation:

* The strategies of the developing countries:

  - the acquisition of technologies;

  - the improvement of local plant varieties;

  - the granting of facilities for preservation, while limiting internal conflict to a minimum.

In relation to the North: avoid blocking resources so as to maintain research and development incentives in biotechnology.

* The strategies of the developed countries:

  - intellectual property rights that encourage R&D through patents;

  - open access to the genetic resources of the South.

In relation to the South: leave it the right to development.

'The system that we propose is compatible with these strategies. Of course, it is necessary to encourage research in the industrialized countries - patents with dependency licenses or PBR - and to' do so there must moreover be open access to the resources of the South - which is the underlying logic of NCH. However, in order to encourage the South to preserve its

biodiversity there must be compensation mechanisms - NCH with open access paid either in monetary terms or by the transfer of technology. Lastly, the Northern states will only accept to finance an international fund if there is parallel private funding.

In this paper we have shown that, for the time being, à strictly private approach is inadequate to resolve the problem of encouraging preservation. The NCH approach, with paid open access, seems preferable from this point of view. However, in view of the problems raised by cumbersome administrative procedures, we have tried to show that the NCH can and should be applied to decision-making (norms, prioritization), whereas incentives must be at least partly linked to a market or price system. In this way, all the actors realize the importance of preservation (not only in the short term) and understand more clearly that a weak patent system is not incompatible with the notion of open access.

To achieve this result, the conditions of access to resources and the institutional mechanisms to be implemented are not neutral. The effectiveness of the various systems of property rights and benefit sharing established in the context of agrobiodiversity, wild-diversity and genetic resources needs to be analyzed. The result is not to choose between common property or private property, but to define for each case, the best property right system. In the same Likewise, another challenge is to reduce the conservation cost for local communities through a negotiated process of identification of management objectives and a recognition of the role of local populations and their institutions in the evolution, understanding and management of biodiversity and genetic resources. This calls for the development of appropriate mediation and evaluation methods proposing indicators for interactions between populations and biodiversity.

Moreover, two questions remain unanswered:

* who may hold these rights (or who are the "farmers" in the farmer’s rights?) and what do they consist of ?

* what share of profits will actually be used to promote in-situ management of local cultivars, which calls for agricultural development and the improvement of local varieties in developing countries ? One of the way for protecting biodiversity is linked to a substantial increase in global funding for research into sustainable agricultural production and a recognition of the positive role of rural communities in biodiversity management.

References

Barbier E.B., Burgess J.C., Folke C., 1994 - Paradise Lost ? The ecological economics of biodiversity, Earthscan, London, 267 p.

Brown, G.J. and J.H. Goldstein (1984), A model for valuing endangered species , Journal of Environmental Economics and Management, vol. 11, n° 4, pp. 303-309

Glachant M., F. Lévêque 1993 : *L'enjeu des ressources génétiques végétales*, Paris, Les Ed. de l'Environnement.

Hayden F.G., 1991 - Instrumental valuation indicators for natural resources and ecosystems, Journal of economic issues, vol 25 pp.917-935.

Henry, C. (1974), ‘Investment decision under uncertainty : the irreversibility effect’. American economic review, vol. 64, pp.1006-1012.

Joly P.-B., M. Trommetter 1991 : "World regulation of genetic resources : is the model of common heritage sustainable ?", International Symposium "Property rights, biotechnology and genetic resources : incentives for innovation and conservation", African Center for Technology Studies, Nairobi, juin.

Joly P.-B., M. Trommetter 1994 : "Conservation du patrimoine génétique : aspects économiques et institutionnels", *Genetics Selection Evolution*, 26, (1) : 331-342.

Lugo A., 1995 - Management of tropical biodiversity, Ecological Applications n° 5, pp. 956-961.

Martin R.B., 1994 - Alternative approaches to sustainable use : what does and doesn't work ?, Conference conservation through sustainable use of wildlife, Brisbane, Australia, 17 p.

Martin R.B., 1994 - The influence of governance on conservation and wildlife utilisation , Conference conservation through sustainable use of wildlife, Brisbane, Australia, 16 p.

Mendelhson,

Moran D., Pearce D., 1997 - the economics of biodiversity, in The International Yearbook of Environmental and ressource Economics, Folmer H., Tietinberg T. (Eds), Edward Elgar, UK, pp. 82-113.

Namkoong G., Boyle T., Gregorius H.R., Joly H., 1996 - Testing criteria and indicators for assessing the sustainability of forest management : Genetic criteria and indicators, CIFOR Working paper n°10, CIFOR Jakarta, 13 p.

Norton-Griffiths & Southey 1995

OECD, 1997 - Economic concepts and the role of market structure in benefit sharing, Group on economic and environment policy integration, expert group on economic aspects of biodiversity, ENV/EPOC/GEEI/BIO/(97)7, 25p. *

OECD, 1997 - Framework for case studies on experiences with the implementation of incentive measures to promote the conservation and the sustainable use of biodiversity, Group on economic and environment policy integration, expert group on economic aspects of biodiversity, ENV/EPOC/GEEI/BIO/(97)2, 20p. *

OECD, 1997 - Handbook for the implementation of incentive measures for the conservation and the sustainable use of biodiversity, Group on economic and environment policy integration, expert group on economic aspects of biodiversity, ENV/EPOC/GEEI/BIO/(97)8, 21p.

Perrings C. *et al.* 1995 : "The economic value of biodiversity", in V.H. Heywood, R.T. Watson, *Global Biodiversity Assessment*, Cambridge, UNEP/Cambridge University Press.

Perrings C., C. Folke, K.G. Mäler 1992 : "The Ecology and the Economics of Biodiversity Loss : The Research Agenda", *Ambio*, 21, (3) : 201-211.

Pistorius R., J. van Wijk 1993 : "Ressources génétiques à exporter", *Le Moniteur de la biotechnologie et du développement*, 15 : 12-15.

Prescott-Allen C., R. Prescott-Allen 1986 : *The First Resource : Wild Species in the North American Economy*, Yale University Press.

Rosenthal J. P., 1996 - Equitable sharing of biodiversity benefits, agreements on genetic resources, Proceedings of OECD International Conference on biodiversity incentives measures, Cairns, Australia, march 25-28, pp. 253-279 (Bab) (2)

Simpson, R. D., R. A. Sedjo and J. W. Reid (1996), 'Valuing biodiversity for use in pharmaceutical

Trommetter M. (1996a).- Is the conservation of genetic resources an insurance ?, MORE 11 : "Contributions by insurance to sustainability" OSLO February 26-27,, International Association for the Study of the Economy of Insurance (Geneva Association)

Trommetter M. (1997) .- How to evaluate a collection of Plant Genetic Resources ?, working paper 9706, INRA/SERD, Grenoble, 26 pages .

Tobey J.A. - Toward a global effort to protect the Earth's biological diversity, World Development, vol. 21, pp. 1931-1945. *(2)

UNEP, 1993 - Estimating benefits from biodiversity in support of national conservation action plans : the costs of inaction, Nairobi, 47 p.

Victor P.A., Kay J.J., Ruitenbeek H.J., 1991 - Ecologie, économie, et prise de décision - indicateurs d'un développement écologiquement durable, Conseil Consultatif Canadien de l'Environnement, Ottawa, 101 p.

Weber, 1997 : Peut-on gérer biologiquement le social ? colloque Harrare

Willinger M. 1996 : "La méthode d'évaluation contingente : de l'observation à la construction des valeurs de préservation", *Natures - Sciences - Sociétés*, 4, (1) : 6-22.