

Draft - 2/5/92

**ACCOUNTING FOR THE ECOSYSTEM  
Who Pays for Conservation?**

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**International Meeting on Problems of the Knowledge and Conservation of Biodiversity**

**Presentation**

**2/14/92**

**Universidad Nacional Autónoma de México**

As we begin the last decade of the last century of this milenia, we can look back upon the achievements of the human race and count among them the near depletion of the earth's natural resources. Along with technological achievements and scientific and medical advancements, we find the extinction of thousands of species, the dismantling of ecosystems, and the eminent deterioration of entire biomes. And as we accept responsibility as a species for environmental degradation, we also search for the causes and effects of human domination in the biosphere. Two points usually arise in such evaluations:

- 1) the accelerated conversion of species-rich ecosystems, whether natural or agricultural, into impoverished ones, and
- 2) the role of the rural poor in such conversions.

The convention in the past has been to lay the blame for the loss of this biodiversity on peasant farmers and colonists in ecologically fragile lands. Yet, evaluations continue to neglect the contributions of peasant farmers and indigenous groups to the conservation of many biologically diverse areas, particularly in the tropics, and the connections between poor land-use practices and the economic capacity of tropical nations to finance conservation practices.

Many arguments have been heard over the years regarding the value of the world's biodiversity and the need to protect the remaining species and ecosystems from degradation. In the case of ecosystems composed of mature vegetation, such arguments are based on the following points:

1. The greatest biological richness of our planet can be found in the remaining original forests of the tropics. The majority of the world's species come from these ecosystems (U.S. AID 1985; Wilson 1988).
2. The scientific knowledge of these species is extremely poor, and an unknown number of species remain undiscovered. Even with those species that are known, often all that is documented are the scientific names and perhaps the taxonomic relationships. Yet, based on the little we do know, the biological richness of the tropics is considered to be one of the potentially most important resources for the future of humanity.
3. The loss of species and biotypes in the tropical regions is occurring at a rate never before realized, and this situation is the result of human activities (Gómez-Pompa *et. al.* 1972; Raven 1984). Some estimates of tropical deforestation show a loss of 11 million hectares per year (FAO), or from 1 to 1.3% annually. In Mexico, deforestation rates are estimated at 615,000 hectares per year or 1.3% of the total forest area (Gómez-Pompa *et. al.* in press).
4. Future alternatives for food, medicine, or industry may be found in these still unknown or little-known species (Vovides and Gómez-Pompa 1977).

5. The value or critical role of individual species in ecosystems is still unknown, and the extraction or extinction of even one species may threaten critical relationships within the entire ecosystem (Ryan 1992)
  
6. Non-human species have intrinsic value beyond their utilitarian value to humans (Ehrenfeld 1978) and their existence and the existence of species-rich ecosystems is of aesthetic, spiritual and moral value to humans as well (Nash 1989).

For all of the foregoing reasons, many scientists and conservationists have long advocated that the conservation of biodiversity be given top priority in national and international policy, with special emphasis on the biological richness and vulnerability of the tropics. Yet, little thought has been given to the pragmatic aspects of implementing such policies or their potential consequences. Who would be the responsible party in designating biodiversity conservation as the highest priority? In Mexico, the importance of conservation of natural areas has been clearly demonstrated and understood by the Mexican scientific community and within high government levels as well. Yet, the current situation is one of accelerated and accelerating deterioration of the biological wealth contained in the Mexican tropics as a result of unchecked deforestation for agricultural or pasture lands.

With respect to the conversion of species-rich agroecosystems into monocultures, several more arguments for biodiversity conservation have arisen, particularly in the last decade:

1. Traditional agricultural and agroforestry systems in the tropics, typically based on the cultivation of many species at the same time on the same parcel of land, have demonstrated their success at genetic conservation and their long-term sustainability via centuries of use (Altieri and Merrick 1987; Gliessman *et. al.*

1981). In contrast, the simpler systems encouraged by the technological packages of modern science mainly offer single cultivars with high levels of production. The sustainability of such production remains unproven.

2. Diversified traditional systems require less capital and technological input, in terms of insecticides and fertilizer, and greater amounts of hand labor. One characteristic of this argument is that such systems should be of special advantage in the tropics, given the high levels of poverty and abundance of available labor [refs].
3. The biological wealth found in species, biotypes, races and varieties of cultivars in traditional agroecosystems represents a wise strategy of great benefit to humanity. Within the foundations of these diversified traditional systems lies the conservation of the genetic diversity of those species upon which the food supply of humanity depends. Examples abound in the literature of the importance of indigenous races of rice, corn, and other basic food crops for the resistance to disease and pests their genes have furnished the present economy crops of the world (Frankel and Soulé 1981).

Just as with mature ecosystems, the worth and economic importance of this form of genetic conservation is unquestioned and well-known by scientists, agronomists, and higher government officials. And, in the same way as with tropical forests, development programs and policies ignore this knowledge, and the conversion of diverse agroecosystems into simpler ones remains an unfortunate reality in many tropical areas.

It is clear that powerful incentives beyond the rationality offered by scientific findings govern this conversion process which undoubtedly seriously threatens the welfare of humanity. The economic and industrial components that have dominated government development programs are based on gaining the most production in the shortest amount of time with technologies that require the least amount of human labor. Such programs have no consideration for the conservation of biological diversity in either mature tropical forests or agroecosystems. It is the immediate profit gained from short-term activities that gives unsustainable agricultural, mining, timber, or pastoral activities top priority in national policies and that accounts for the predominance of poor land-use among individuals and private groups with economic interests in tropical forests.

The challenge for the scientific and conservation community lies in presenting a multiperspective understanding of the problem of biodiversity loss, along with the practical and logistical consequences of biodiversity conservation. A more pragmatic approach, one that includes the economic interests and necessities of peasant households and tropical nations, might be able to recommend more feasible actions that are economically, socially, and politically viable, in place of the often utopic solutions that have previously been proposed by the scientific community.

The argument between preservationism and utilitarianism in conservation is a long-standing polemic. However, regardless of our own personal inclinations, a preservationist policy for the tropics to prevent the conversion of mature vegetation into productive agricultural, pastoral, or forestry systems is not cost-effective in the immediate or near future. Nobody gains direct economic benefits by leaving the tropical forest unused or by setting it aside for biodiversity conservation.

And the transformation of the tropical forest ecosystems into production systems offers economic benefits for the companies that clear and harvest the forests and for the

agricultural and livestock producers. Such use implies the transformation of the value of natural resources into hard currency, which stimulates the local economy and, in turn, benefits many sectors of the rural population.

In order to slow or reverse this process of ecological transformation, economic and political arguments must be considered alongside biological ones. From a more diverse perspective, it can be seen that the cost of not converting an ecosystem is equivalent to the actual or potential value of the transformation. The question then becomes: Who will be responsible for covering the cost of conservation? And from where will the economic resources come to compensate those who might benefit from the environment's conversion?

If the cost ought to be charged to the beneficiary, then the key question is: Who benefits from biodiversity conservation? In the answer to this question lies the complex and diverse dimensions of the benefits of biodiversity to the planet. However, the most obvious beneficiary of biodiversity conservation is the human species, humanity itself. The cost of a local action that prevents the conversion of a species-rich ecosystem should be paid for by the rest of the world to those directly affected economically.

This payment could be applied at the national level as well. In Mexico's case, one of the benefits of biodiversity conservation would be the biological alternatives opened for the future of the republic. The entire nation, rather than the rural populations, should account for its responsibilities and pay for the economic consequences of biological conservation.

Given the poverty of the great majority of tropical countries and the use of raw products from these countries by wealthier nations, some responsibility for biodiversity belongs at the international level as well. Up until now, the responsibility for the conservation of biological diversity in tropical countries has fallen on the shoulders of the poorest sectors within these nations. The few futile efforts that do exist in tropical regions have been financed by the tropical countries, although they include some of the poorest nations of the world. Yet, the rest of the world, the ultimate beneficiary of these actions, contributes practically nothing to their funding.

The unfortunate reality is that conservation compensations have not occurred, not in Mexico, not in the world, and, to date, the conservation of biodiversity in the tropics is paid for by the local and regional inhabitants. This situation accounts for some of the hostility manifested in some regions towards ecological conservation efforts.

The same considerations need to be given when discussing the conversion of species-rich agroecosystems into monocultures. The main difference in this type of conversion is that both types of agricultural systems are productive and both benefit the rural economy. For this reason, agroecosystem conversion is not as critical an issue as tropical deforestation.

Peasant farmers that maintain their traditional agroecosystems do so because they do not know of other systems that would perhaps be more lucrative. Their poverty and isolation prevents them from investing in the techniques and infrastructure required by modern agriculture to boost production. This has protected many traditional systems from conversion and has consequently conserved crops of great ecological and agronomic importance. If advanced technological alternatives were available and affordable for

peasant farmers, it would be inevitable that farmers would adopt those practices that provided the best results with the least amount of effort.

In fact, this is exactly what is happening in the Mexican countryside. The use of pesticides and herbicides is already a common practice in even the most remote regions. The decision to adopt or not adopt nonorganic agricultural methods is not based on the long-term worth of the techniques or the consequences of chemical investments or, least of all, the ecological impact of these practices; decisions are ultimately based on the availability of capital or credit (Gladwin 1976). No bank credit or government aid is available to not use the land.

Credit is also not available for activities that sustain the peasant household in place of commodity production, even though families in rural areas rely on a wide range of products from their land, from alternative food crops to thatch or fodder. And these necessities in turn encourage the maintenance of a variety of species in and surrounding the cultivated land. Some of these species are wild or semidomesticated relatives of the world's basic food crops. Yet, the maintenance of traditional agroecosystems involves time and labor inputs that are not always valued in the marketplace or by the bank. As a result, the additional costs of many of the techniques used in diversified agroecosystems, especially those that conserve genetic diversity, are absorbed by the peasant farmers who are cultivating, caring for, and thereby conserving important genetic resources.


However, given the option of monocropping with a highly productive variety of a commercial cultivar (perhaps with the opportunity for credit and machinery), the peasant farmer can be expected to choose a single species system over a multicrop one. If this choice were not hypothetical, the genetic diversity found in traditional agroecosystems



would be in as critical danger as that found in mature tropical forests. And if the conservation of traditional agroecosystems is insisted upon by the international conservation community, the same responsibilities for local compensation apply that were discussed for tropical forest conservation. Conservation is not free in either case, and some sector of humanity ends up paying for the conservation of the crop varieties important to humanity. To date, the conservation of indigenous crop varieties has been primarily paid for by the traditional farming groups in the regions where the crops are found. In these cases, we can be thankful that modern technology has not been very successful in providing alternative systems that are more efficient and adapted to the economic and ecological conditions of tropical zones (see Brush 1986). However, this will soon change, judging by the present trends to optimize production via the industrial agriculture typical of the Green Revolution.

A few conclusions can be outlined based on the foregoing discussion, though they might be a little optimistic. Tropical conservation, whether of mature forest or crop varieties, ought to be an obligation and responsibility for all the planet's inhabitants, and all should contribute to its support and maintenance. A few programs of this nature do exist, most notable the efforts of FAO and UNESCO via the Tropical Forest Action Plan and the Man and the Biosphere Programme. Other more recent initiatives include: 1) the Global Strategy and Action Programme for Conserving Biodiversity supported by the United Nations Environmental Programme (UNEP), the World Resources Institute (WRI), and the International Union for the Conservation of Nature (IUCN), and 2) the Global Environment Facility created by an alliance of the World Bank, UNEP, and the United Nations Development Programme (UNDP). Though all these programs are commendable efforts, the funding for them is ridiculous in comparison to bigger development projects that include ecologically destructive practices.

In order to maintain the genetic diversity of the planet, it is humanity that holds the responsibility to finance the actions that conserve it. Such funding should come from those sectors that benefit, possibly through a clearly designated tax for this under international and national supervision, given that the beneficiaries would come from different countries. Consumers of the world's natural resources have as much a responsibility to contribute to the biosphere's stability as to their nations' stability. They also share a responsibility to contribute to the maintenance of the natural resources which supply the raw materials for their present lifestyle. [The administration of international conservation contributions would be a worthwhile project for the United Nations.]



International financing and responsibilities touches on an important, though little discussed, issue of ownership of biological and genetic diversity. When we, as conservationists and scientists, speak of "alternatives for humanity", we are in reality speaking of the benefits that biodiversity provides for those people and institutions that have the ability and knowledge to transform the raw material from a potential to an actual resource.

Historically, the biological wealth of a country has not been equal to its economic status, though the natural resources of the country may have high international worth. Instead, this biological wealth may benefit a completely different country. The rubber resources of Brazil provide a notable example where the country of origin has benefitted little from the cultivation of rubber, though the germplasm comes from Brazil and the greatest diversity for rubber is found there. Brazil's rubber has been a source of economic development for Malaysia instead. This does not represent a unique case and perhaps points out a dangerous future trend for economic inequities between nations. The value and benefits of the tropic's natural resources belong to the countries with the scientific

and technological capacity to research and transform the raw resource into a commodity. Without a doubt, tropical countries are at a disadvantage in comparison to their northern neighbors. The scientific and technical infrastructure in tropical countries remains precarious, and the ability to compete with wealthier nations on the international market, even with homegrown resources, is very limited (though there are some notable exceptions).

Unfortunately, the possibility of regulating the extraction of the biological resources in tropical countries is nearly impossible. Even those countries that jealously insure that their genetic wealth stays within their borders know that such regulation is not really feasible. The human and economic resources that are needed for this sort of protection would be at such a cost as to render any protective actions unjustifiable. In addition, modern techniques of tissue cultures and micrografts make any sort of restrictive actions of this sort unenforceable.

Even the possibility of regulating the free use and transfer of biological and genetic resources through agreements established via the United Nations is a utopian suggestion. The great potential of many resources is found in their chemical structures which, in turn, can be copied, manipulated, improved and patented. This was the case with Mexican Barbasco, *Dioscorea composita*, from which a natural sapogenin [???], diosgenine, can be extracted. This compound is found in many other species of *Dioscorea* throughout Mexico and other tropical countries. It is transformed through various chemical processes into esteroidal [steroid?] hormones. The transformation processes have been patented by the chemical companies.

For this reason, those countries that possess the original primary vegetal material and even the economic resources for its production still find themselves restricted in the use of *Dioscorea* unless they pay the corresponding royalties for the patents. The possibility of patenting the actual plant or some of its more productive varieties is also not a reasonable alternative. If the raw material continues to be used lucratively in the future, it will be cultivated via high production techniques rather than collected from the wild. This example, only one of many, points to a disturbing trend in the recognition of the value of genetic diversity.

Given these realities, what is the path to follow for the conservation of genetic and biological diversity? Obviously, no easy or quick answer can be given when one considers the complex web of social, economic, and political interests that affect land-use in tropical countries. However, some basic recommendations for biodiversity conservation can be offered:

1. The conservation of genetic and biological diversity is the responsibility of all of humanity, and in accordance with the corresponding economic potential, each nation should participate in environmental conservation, from the national to the international level.
2. Tropical countries need to develop a solid scientific and technical infrastructure in order to benefit from their own genetic resources, coupled with a clear vision of the economic and social importance of those resources for the nation.
3. National development strategies should include *in-situ* and *ex-situ* conservation practices in their agendas, including clear and active initiatives to support these activities.

4. The use of erroneous arguments in favor of conservation that are without scientific basis should be avoided (Gómez-Pompa 1985), and a more pragmatic attitude adopted if we are to conserve the biotic patrimony of humanity.
  
5. The knowledge and experience, good or bad, of peasant farmers and indigenous groups must be recognized and included in conservation strategies. Local inhabitants of ecologically fragile areas need to be included in the decisions that affect their lives and compensated for those actions which limit their own economic development.
  
6. Serious consideration needs to be given to an international tax on activities related to the use of world resources or cultivars. The proceeds would be directed towards conservation and sustainable land-use to insure that these natural resources are not depleted and that just compensation exists for those who bear the cost of international benefits.

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