(iv) *Monitoring and Analytical Methods. Problems Related to Evaluation of Data*: E. Mentasti, Italy, reported on the state of the art in instrumentation for the determination of ultratraces of metal species in environmental samples. Results have been presented on flow-injection analysis/atomic spectrometry instrumentation. Enrichment of the analytes may be achieved with low sample contamination, and possibilities for speciation studies were also presented. S. Jensen, Sweden, showed that the measurement of concentrations of persistent bioaccumulating chemicals in ecological samples is an important tool in ecotoxicological science. A database from the Swedish Contaminant Programme covering the period 1969–1989 is available, with interesting data, i.a. on PCBs, DDT, and organomercury compounds. Correlation with age shows increased accumulation as well as data uncertainty and spread; breeding periods also correspond to higher accumulation of PCB by a factor of 5–10. Mean values over a period of 20 years of monitoring show that in this period PCBs have nearly halved. Data for methylmercury were also presented.

I. Allegrini, Italy, showed the fate and peculiarities of primary and secondary pollutants; spread in ecosystems in the Italian peninsula, with distribution through convection channels, where geomorphology is of higher importance. The analysis of several atmospheric pollutants has been achieved by using selective sample denuders, which allow automation and remote operation. The cycles of hydrocarbons, $HNO_3$ and ammonium salts were defined with these devices. The importance of calibration was emphasized. P. Ciccioli, Italy, stressed the importance of determining organic compounds (VOC).

A. Södergren, Sweden, presented data on the consumption of paper in the world. The treatment of wood with chloro-soda processes has produced more than 50 tons per day of organochloro compounds in Sweden. Recent laws advocate new industrial treatments with lower environmental impact. The consequences of these wastes were discussed with reference to the parameters extractable organic chlorine (EOCl), and adsorbable organic halogens (AOX). These compounds are taken up by fish and lead to accumulation. Methods and standardizations for toxicological parameters are needed, and cooperation must focus on these goals. G. Crescentini, Italy, discussed protocols for chromatographic procedures for organics as pollutants. In this respect, the Master Analytical System (MAS) represents an effort to develop a comprehensive qualitative/quantitative procedure for analysis of organic compounds in water. T. Westermark, Sweden, provided an impressive and interesting discussion on problems connected with biomonitoring of pollutants in a historical perspective. He presented data from analyses of chemicals, particularly metals, deposited in the shells of mussels and snails. These depositions occur in connection with the annual increment of growth and their occurrence and location in the shells can therefore be dated. As some species of mussels reach ages of over 100 years, they constitute a unique historical data bank for chemical exposure.

The seminar participants pointed out the desirability and importance of interdisciplinary cooperation between the Swedish and Italian scientific community. Cooperation among scientists within a single discipline was also suggested. The main areas for possible cooperations suggested were:

- Methods development with concomitant interlaboratory studies and evaluations.
- Development of protocols for the qualitative and quantitative determination of unknown uptake. These studies should also consider the ratio between benefits and costs of analytical data uptake.
- Cooperation on toxicological and ecotoxicological studies of anthropogenic compounds was also stressed.

The proceedings from the symposium will be published in *Annali de Chimica* of the Chemical Society in Italy.

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# Biodiversity, Bioproductivity and Biotechnology

## BIO-WEALTH

The UNCED process helped to place the loss of biodiversity and its conservation on the global agenda, resulting in biodiversity becoming a household word. In essence, biodiversity is a new name for species-richness (plants, animals and micro-organisms) occurring as an interacting system in a given habitat. Basically, the problem of biodiversity is one of conflict resolution between man on the one side, and most living organisms occurring on land, in freshwater bodies, and the marine environment on the other. Biodiversity is an irreplaceable resource. Its extinction is for ever; at present there is no way to recreate extinct plants and animals. Having become a buzz word, there is considerable myth associated with biodiversity. There is not only a need to formulate meaningful programs for its conservation and sustainable utilization, but also to demystify the subject and to make people knowledgeable about the tremendous implication for human survival.

India is a country rich in biodiversity, which is important both for the health of the biosphere and for agriculture, animal husbandry, fisheries, forestry and the pharmaceutical industry. It is backed by cultural diversity and idigenous systems of medicine, and knowledge and wisdom of indigenous peoples and is supported by a strong scientific and technological base. Biodiversity is the foundation of all bio-industrial development in the unusually large rural sector of the country. The real value of biodiversity lies in the information that is encoded in genes and molecules.

India has over 115 000 species of plants and animals already identified and described. In addition, India is an important Vavilovian Centre of Diversity and Origin, with over 167 important cultivated plant species and several domesticated animals. Crops that originated in India and spread throughout the world are rice, sugarcane, Asiatic vignas, jute, mango, citrus, banana, several species of millets, spices, medicinals, aromatics and ornamentals, etc. (1).

A large number of institutions in India are involved in conservation and utilization of biodiversity. These fall under the Ministries of Environment and Forests, Agriculture and Science and Technology.

Between them these deal with *in situ* conservation (biosphere reserves, national parks, wildlife sanctuaries), *ex situ* conservation (field gene banks, seed and other banks), and utilization (gene and drug prospecting). India is uniquely placed as far as its biodiversity is concerned, but can no longer go only by its tiger-bird-wildlife syndrome. These are important in their own right, but are a minuscule part of the large spectrum now encompassed in biodiversity.

In most of the developing countries, biodiversity is generally related to environment and forestry agencies, which often have no experience of product development. Furthermore, these countries have yet to comprehend the vast social, economic, scientific, technological, eco-logical, and political potential of this resource. If the current situation continues these countries are likely to be left out in the race to conserve and sustainably utilize their natural resources for the well-being of their people and the world at large. There is also the risk that they end up exporting their natural resources as was the case in the colonial period.

Often, those responsible for the conservation of biodiversity have little knowledge about those who utilize the resources and vice versa. However, policy makers have to realize that conservation and sustainable utilization of natural resources need to be central to all development planning for the developing countries, because these rely predominantly on agriculture for their well being. A national commitment is needed, and therefore there is an urgent need for coordination between the various ministries, organizations and institutes.

The recent agreement between INBio (Institute of Biodiversity in Costa Rica) and Merck, (USA) is hailed throughout the industrial world as a landmark. Under this agreement, extracts from wild plants, insects and microorganisms from Costa Rica are supplied for drug-screening programs to Merck, USA. In return, INBio has received from Merck over USD 1.35 million, and expects royalties on the commercial products that may result from this cooperation. INBio is to contribute 10% of the budget and 50% of any royalty to the Government of Costa Rica for its National Parks Service. Merck has also offered to provide technical assistance and training to help establish drug-research capability in Costa Rica. The Governmemt of Costa Rica has given INBio nonexclusive rights to bioprospect and to share the revenues from this venture with the government. Revenues will be used for conservation work. INBio represents an alliance between biologists/biochemists and businessmen (2).

Costa Rica has over 84 500 species of plants and animals in a 51 000 km$^2$ area. This number is more than that found in Canada and USA combined. Unlike India and some other developing countries, Costa Rica is not a Centre of Diversity and Origin for any cultivated plants or domesticated animals. There are also no indigenous peoples in Costa Rica; normally these peoples are an important storehouse of knowledge and wisdom on plants and animals (2).

The pharmaceutical industry in industrial countries is very influential so far, it has eulogized the INBio-Merck in the press and on TV and radio. There is a growing feeling that industry is attempting to influence public opinion in the biodiversity-rich but technology-poor tropical and subtropical developing countries in the world. The underlying idea may be to induce these countries to follow the Costa Rican approach. Some developing countries are already on their way to doing so.

However, a visit to INBio indicates that in its present form it is something of a "clearing house" rather than an R & D institute of any significance. The only current program is an inventory of Costa Rican biodiversity. In the past, such work was in fact, done by American biologists. One only hopes that INBio will grow scientifically and technologically and be able to take up such work independently.

## BIODIVERSITY AND BIO-TEHCNOLOGY

Natural resources are one of the major assets of the developing countries. In the 1930s, when most of the world was largely asleep, N.I. Vavilov of USSR was wide awake. His monumental studies showed that there have been some major centers of diversity and origin of crop plants and domesticated animals. Most of these centers are in the tropical-subtropical-hot-temperate belt where most developing countries are located (1). It is ironical that while developing countries have given agri-biodiversity to the world, they themselves have been areas of low productivity and high population density. This belt has also been a traditional "hunger belt". Figure 1 shows that low biodiversity and low bioproductivity have been prevalent in harsh ecosystems. Pre-Green Revolution agriculture was based on high diversity and low bioproductivity. The world then moved to high productivity accompanied by low diversity and the result was a Green Revolution. Today, we know that the Green Revolution has paid dividends and in many developing countries acute hunger is no longer a major problem. However, this progress has not been ecologically friendly. Among other things, sustainability in agriculture, animal husbandry, fisheries and forestry, depends on the ability to combine high productivity with high diversity. Agriculture all over the world will need to move towards such a broad goal. Therefore, studies of the relationship between biodiversity, bioproductivity and bio-technology are vital.

Although the "gene and drug rush" is inevitable, it should not take place in a policy vacuum. The central issue is that formulation of policies in gene-rich/technology-poor (or deficient) countries is necessary to avoid what could result in "gene imperialism". The INBio experience, if implemented without thought and care, could prove to be the thin end of the wedge. Therefore, each country must ensure that such agreements do not have the objectives of conservation, sustainable utilization, development and equity in biodiversity. Biotechnology is inherently knowledge-intensive, and a good biotech infrastructure would lead to added value to products from agriculture, animal husbandry, fisheries, forestry and medicine.

The institutional structure that controls biotechnology should not overshadow those institutions that deal with biodiversity conservation, and on no account ignore the rights and privileges of the local communities. While the former involves advanced science and technology, conservation is largely languishing even for simple and time-tested scientific and technological inputs.

Technology transfer, for biotechnology, requires a certain minimum amount of technical and legal capability, which the developing countries lack. Therefore, there is a need for considerable competence and skills in a whole range of subjects starting with taxonomy, genetics, plant breeding, molecular biology, micobiology, biochemistry, fermentation technology, biochemical and process engineering, economics, law, and training of local communities in modern conservation skills. Furthermore, if the scientific and technological efforts in conservation and sustainable utilization are not properly focused there will be failure to achieve tangible results. For the promotion of biodiversity conservation and sustainable utilization, the developing countries must not only concentrate capacity building, but also work towards innovation, acquisition and adaptation of relevant biotechnologies, legal aspects, trade secrets, IPRs, patents, petty patents, and plant breeders' and farmers' rights. This has to be supported by a proper economic and political climate, and a proper balance between those who conserve and those who use natural resources. Thus, technologies to harvest returns from agriculture and the drug industry are needed. At the same time, local people should be empowered to conserve and use natural resources, and to participate in management.

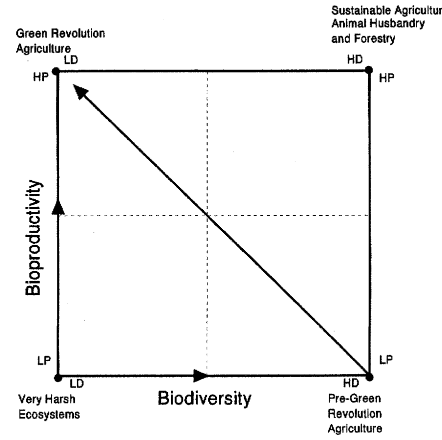


**Figure 1. Relationship between bioproductivity and biodiversity.**

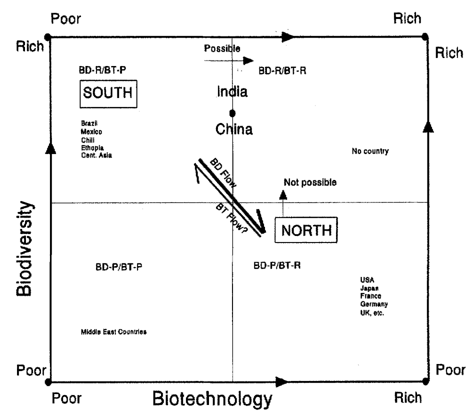


**Figure 2. Relationship between biodiversity and biotechnology.**

While a whole range of existing laws on protected areas, wild life, land use, forestry, water, mining, grazing, etc. promote conservation of biodiversity, they do not promote their sustainable utilization. We lack an all-encompassing law on biodiversity that should take into account its interconnection with biotechnology. This would be one tangible step towards sustainable bioprospecting.

The relationship between biodiversity and biotechnology is shown in Figure 2. The countries of the world have been divided into four groups: (i) biodiversity-poor and biotechnology-poor; (ii) biodiversity-poor but biotechnology-rich; (iii) biodiversity-rich but biotechnology-poor; and (iv) biodiversity-rich and biotechnology rich. To the first group belong countries in the Middle East, e.g. Saudia Arabia; to the second group belong the USA, Japan, Germany, France, Sweden and the UK; the third group comprises countries like Indonesia, India, China, Malaysia, Brazil, Mexico and others; no country falls in the fourth group.

At present there is a flow of biodiversity from the third group (South) to the second group (North). The extent and nature of flow of biotechnology from South to North is virtually nonexistent. This is an unequal exchange and will remain so until such time when countries in the South become self-reliant in biotechnology. An important factor underlying this exchange is that while some countries, like India and China, have the capability to enter the fourth group the countries of the North can never make it to the fourth group in the real sense of the term. The reason being that they do not have any worthwhile natural agri-biodiversity, although they do have excellent *ex situ* facilities in the form of field gene banks, seed, and other banks. The latter do not have the advantage of the ecological processes and organic evolution that operate under natural conditions. In essence, these are "gene morgues", because advantages conferred by exposure to the process of natural selection are not available. In contrast to *in situ* conditions, organic evolution is virtually at a stand still or halted under *ex situ* conditions. Therefore, in all bio-banks, germplasm is preserved and not conserved in space and time. However, both *in situ* and *ex situ* conservation are necessary to complement each other.

Gene-rich/technology-poor developing countries must, therefore, come together and reach an understanding on various levels, including scientific and technological economic, social, cultural and legal issues, and collection, supply and costing of raw materials. Today, the cost of biodiversity is the cost of collection and travel involved. If these countries remain divided regarding their stand on prospecting for new genes and drugs and IPR, and compete among themselves, the type of benefits that INBio has been able obtain from Merck, USA, will no longer be forthcoming.

It is, therefore, imperative that a multilateral mechanism is created. One step towards this may be that this matter be placed on the Agenda of the G-15 countries, where other gene-rich/technology-poor developing countries are also invited, or the G-15 is itself appropriately widened to include such countries. The joint group must explore the possibility of working out a multilateral agreement like that of the OPEC (Organization of Petroleum Exporting Countries). In such a venture, "teething" problems are inevitable particularly because, unlike oil, genes are still to be recognized as strategic materials. Past experience with products such as rubber, coffee, cocoa, tea, palm oil and jute is not encouraging. The time for such a multilateral mechanism is most appropriate becasue of the tremendous global upsurge of interest in natural products and vegetarianism. Industry would be ready to make investments in this area because gene and drug screening technology itself has reached a level of perfection.

The extent and nature of biotechnology capability will determine the capability of the country to conserve and sustainably utilize its natural resources. Conservation is no longer only a function of building a fence round an area, but it involves a considerable amount of upstream biotechnology. The longer a country takes to make a changeover, the farther the country would be from reaping the harvest of rich biodiversity.

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# Impact of Culture on Process of Joint Forest Management in India

Culture is a relevant attribute for developing an institutionalized process of Joint Forest Management (JFM). The domineering cultural characteristics of rural masses, frontline forest functionaries, and sociocultural subtleties during their interactions, have significant implications for administration of JFM.

If the objective is to cook a dinosaur the management options are many; e.g. prepare a large urn to boil it in or to cut it into smaller pieces and cook it collectively. Success depends on the degree of resources available and the collective capabilities of the cooks. When drawing an analogy for managing the forests jointly, it is important to take into account the capabilities of the people as well as natural-resource managers. The issue of collective capability has a direct bearing on training input and sociocultural background. An understanding of the sociocultural background of actors may depict cultural traits which impede or catalyze the process of JFM.

According to Edward Taylor, "Culture is that complex whole which includes knowledge, belief, art, moral, law, customs, traditions, norms and any other capabilities acquired by man as a member of society. The culture denotes acquired behaviors which are shared by and transmitted among the members of society. Culture is both an asset and a liability" (1). It is an asset because shared values generate higher levels of cooperation, commitment, commmunication and the participatory decision making essential for the process of JFM. It becomes a liability when shared values and beliefs do not conform to the needs of sustained ecological development.

Culture has a role to play in the development that will enable people to live in harmony with nature. It is possible to utilize the cultural ethos in the very task of development by recognizing its centrality for individuals and communities (2). Through JFM, there is scope for designing development that includes cultural patterns and cultural sensibilities.

Today, the concept of Joint Forest Management (JFM) is deeply rooted in forest administration. The policy aims to link the socioeconomic interests of the rural dwellers in and around forests with the sustainable management of these areas while maintaining environmental stability and ecological security. The success of the JFM process in an area depends on the extent of natural-resource endowment, and the sociocultural background of the actors,

(i) *Recipient system*: People who receive the benefits of certain village development program.
(ii) *Delivery system*: Natural-resource managers such as foresters, village-level government officials, NGOs, etc., who facilitate benefits to rural masses.
(iii) *Interactive system*: Interactive systems exist which may be rough or smooth depending upon gaps in role expectations. Ideally, while managing the forests jointly, interactive systems should work smoothly but frictionless interaction is seldom possible.

In Haryana, there are 39 Hill Resource Management Societies (HRMS). Authorities appear to be fully satisfied with the working of six societies; 23 societies are running poorly, whereas 10 societies are somewhere in between. The reasons for different performance may be attributed to cultural characteristics which have either worked as inhibitors or catalysts in the institutionalization of JFM projects.

## SOCIOCULTURAL CHARACTERISTICS OF RECIPIENT SYSTEMS

Rural people in the traditional shape of marginal farmer/small farmer/landless laborer have to be brought over from primitive or subsistence agriculture with low productivity and low economic resilience to higher production levels through increases in wage employment and entrepreneurial activity. Village people often have patterns of culture which are integrated with the forest cycle; from collection of seeds to harvesting of crops. Forestry operations and societal rituals are closely connected. This interlocking deserves to be appreciated and utilized in the planning and development process.

The sociocultural characteristics of the recipient system include:

- People in the village see the government officials as Mai-Bap. The degree of dependence and expectation of nurturance from the department (spoon feeding) is high. People see authority in absolute terms.
- Rural elites monopolize credit and marketing facilities. Elites have the knowl-