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2 JAN 2002
Dy. No. 31
New Delhi

To

December 21, 2001

Mr. Ashish Kothari
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Kalpavriksh
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Dear Mr. Ashish,

We had received your comments and suggestions for the paper on Eco-Technology. We have revised the paper accordingly. Please find herewith the paper entitled "Industry, Technology and Biodiversity.

With regards

Sincerely yours

[signature] 21/12/01
(Sanjay Tomar)

WISHING YOU A HAPPY NEW YEAR 2002.

AGM(A)
M(AKB) Anil 11/1/02
File - 72Q

NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN (NBSAP)

Thematic Paper

INDUSTRY, TECHNOLOGY AND BIODIVERSITY

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OUTLINE

1. Introduction

India the second largest country in Asia and seventh in world, has a total geographical area of 329 million hectares with a coast line of over 7500 km. The great geographical expanse of the country has resulted into enormous ecological diversity. The diversity ranges from sea level to the highest mountain ranges in the world; hot, arid conditions in the west to tropical evergreen forests in North-East India and the western ghats; cold arid conditions in the trans Himalayan region to mangroves of Sunderbans and fresh aquatic to marine ecosystems. Thus, India has a representation of 12 biogeographical provinces, five biomes and three bioregion domains resulting into an array of habitats like forests, grasslands, wetlands, coastal, marine and desert ecosystems each with rich floristic diversity characteristics of its own. These biological attributes are further enhanced by the geographic location of the country at the confluence of three major global biogeographical realms *viz.* Indo-Malayan, Eurasian and Afro-Tropical, thus allowing the intermingling of floristic elements from these regions as well and making it one of the 12 mega biodiversity centers of the world.

As the modern technology advances, so does our ability to change our surroundings. Changes made on surface of the Earth today are more extensive and occur more rapidly than ever before. The ramifications of these changes have become more significant with the increase in world population, resulting in decline of available per capita land. Environment is loosing its resilience where the intensity of human interventions is high. However, the changes in the environment and consequently on the biodiversity are associated with demographic and economic changes. The continuing loss of India's forests due to agriculture expansion, industrialization and technological advancements are leading to massive environmental disruptions, including an historical unprecedented rate of species extinction.

Much of the threat to the biodiversity of the country is due to habitat loss resulting from land degradation, industrialization and loss of prime ecosystems to meet the shelter needs of the burgeoning population. The richest repositories of biodiversity - the forests, rivers and oceans are under serious threat from industrial and technological developments in our country. From the ecosystem diversity point of view, floral, marine and aquatic biodiversity are facing the brunt due to intensive commercialization and industrialization.

As the National Biodiversity Strategy Action Plan initiative is working at different levels including ecological zones and geographical spread, in this paper we would primarily be looking at the impact of industrial and technological developments on biodiversity where it is densely concentrated and where it is the main source of direct and indirect livelihood for a large section of the country's population.

2. Background

Technology and industrial development have advanced enormously over the last few decades. These developments have an impact on biodiversity conservation and use. These impacts have enhanced the biodiversity in some cases (*e.g.* tissue culture have made it possible to propagate the endangered plant species), while it has negative impact on the others. As a result of the technological advancements, we now have the fast evolving information systems and genetic engineering. Similarly, there have been great advances in transport, sources of energy, food technology, medicine and construction *etc*. However, when we look at the environmental spheres it seems that the world is going backwards. The environment is still deteriorating, forests are diminishing and soils are eroding. The climate is changing, water availability is getting less, plants and animal species are still disappearing. The danger now is that as the advances in technology catch our imaginations in the virtual world of internet and in the published reports, at the same time we run the risk of forgetting and seeing what is happening in the real world. This has a great implication on the research (particularly in agriculture/horticulture field) as it is more of academic and theoretical in nature. There is need to conserve the traditional knowledge and integrate it with the current technologies. Technologies that can work to benefit of the environment can be classified into:

- Those which *reduce* the environmental damage by alleviating the direct pressure on natural resources or by reducing the pollution load through modifying the chemical or physical characteristics of work products
- Technologies which *enhance* natural resources *i.e.* make them more productive or richer
- Technologies that *save natural resources* and allow us to get more revenue from the same resource or to get the same from less
- Technologies that *turn waste* into products by closing cycles.

India has witnessed rapid industrialization in its attempt to emerge as a modern nation. These have primarily been in the areas of construction - large scale dams, mega power projects, mining for minerals and other natural resources for internal consumption and export *etc*. Due to increase in population and subsequently to meet their demands for food, shelter and energy, has resulted in expansion of the agriculture, construction and exploration industries. However, this has affected the country's biodiversity. Industrialization with its thrust on exploiting biological resources as raw material has been destructive to the biological wealth of the nation. Hence present emphasis should be to develop environmentally and socially sound technologies (development/application/use of technology and industrial processes) which either do not cause damage or has less impact on biodiversity.

Being primarily an agrarian country agriculture and fisheries have been the prime occupation and livelihood of several people of India and construction is another area where a large number of people are employed. While the first two are themselves components of the vast biological wealth of the country, the later is a major activity with adverse impacts on biodiversity.

3. Eco- Technologies

Technologies for developments/innovations are primarily aimed at cutting cost, improving efficiency and increasing outputs. Hence, most of the technologies have an adverse impact on the environment. However, technology and industries have made it possible to bring to all people of the Earth prosperity, well being and opportunities undreamed by the earlier generation. Simultaneously this has produced a series of deepening environmental and social imbalances, which are affecting the biological diversity of the country.

There is much to learn from the past in terms of the ecological and social sustainability of technologies. At the same time, new developments have opened up new opportunities for developing technologies, which can lead to higher productivity without adverse impact on the natural resources base. Eco-technology involves blending frontier technologies such as information, space and biotechnology with the ecological prudence and practices of local communities. Since land and water are shrinking resources for agriculture, there is no option except to produce more food and other agricultural commodities from less per capita arable land and irrigation water. In other words, the need for more food has to be met through higher yields per units of land, water, energy and time. It would therefore be useful to adopt eco-technologies to meet this demand without associated ecological harm to the biological diversity. The technology blending should be done jointly with the stakeholders in a participatory research mode so that the technologies can be adopted by the end users.

Emerging farming technologies should be based on precision farming methods. Hence precision farming will be knowledge intensive, using information from remote sensing, Geographical Information System (GIS), Global Positioning Systems (GPS), and computer technologies. Farmers in industrialized countries are already using satellite imagery and GPS for early detection of diseases and pests, and to target the application of pesticides and fertilizer accordingly. Among other recent tools, the GIS methodology is an effective one for solving complex planning, management and priority setting problems. Similarly, remote-sensing technology can be mobilized in programmes designed to ensure drinking water security and management of forests. Biotechnology will play an increasingly important role in strengthening food, water and health security systems.

In India it is estimated that more than half of the population have to rely on wood, dung and crop residues to provide the fuel they need for cooking their food and keeping themselves warm during the winters. There is a need to provide alternate sources of energy which will reduce the pressure on the natural resources. Providing electricity has, in the past, focused on the extension of the national grid with power generated at large, central power stations. The cost has become very high in this case. Energy generated and used locally avoids transmission loss, creates employment, reduces pressure on the natural resources and become affordable. Nepal and China are two countries where micro - and mini - electricity projects are now beginning to provide energy in some of the remote rural areas. Not all the regions are blessed with the abundance of hydropower availability. Hence, there should be focus on other technologies that can meet most needs by harnessing wind power, solar energy and biomass. The technologies are there in most of the areas, but missing is expertise, finance and management once the scheme is up and running.

4. Industrial and Technological Developments

In the last few decades, industrial and technological developments have prompted both social and ecological disruptions. The impact of industrial and technological developments is felt most in areas where there is concentration of biological wealth. Many industries extract raw material from the natural resources and hence affect the diversity. Deforestation has led to the loss of natural forest cover and biodiversity of the country. Similarly mining, construction of dams and roads have also resulted in the loss of biodiversity.

The present paper analyses the impact of industrialization and technological developments in four major areas (*viz.* Agriculture, Fisheries, Forestry and Mining) where there have been rapid developments and which are activities which affect areas with high concentration of highly productive "biological systems".

4.1 Agriculture

The agricultural revolution has been the most fundamental innovation in the history of the cultural and socio-economic development of humankind. The term "Green Revolution" has come to be associated not only with the higher production through enhanced productivity, but also with several negative ecological and social consequences. These consequences have resulted in the decline of the biodiversity. Due to the expansion of the agricultural frontier through the centuries to provide food and goods for an ever increasing human population, it has been mentioned that agriculture has been a human activity intrinsically destructive of biological diversity. There is also frequent reference to the "fatigue of the green revolution" due to stagnation in yield levels and to a larger quantity of nutrients required to produce the same yield as in the early 1970s. It has been estimated that there will be an impending global food crisis due to increase in population, increasing purchasing power leading to the consumption of more animal products, increasing damage to the ecological foundations of agriculture, declining per capita availability of land and water and the absence of technology that can further enhance the yield potential of major food crops. Hence at this stage a paradigm shift is required in agricultural***
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*****************ogen per hectare, together with other major and micro nutrients. Addition of such nutrients solely through mineral fertilizers will lead to serious environmental problems. Hence, the introduction of legumes, particularly efficient stem modulating and photo insensitive strains of *Sesbania rostrata*, in the rotation are important.

Traces of fertilizers and pesticides are washed into the nearest water bodies at the onset of the monsoons or whenever there are heavy showers. As the point of entry of such agricultural inputs is diffused throughout the river basin, they are termed non-point sources of pollution. This affects the aquatic diversity of the region.

The future belongs to small farm families taking to precision agriculture, involving the use of the right inputs at the right time and in the right way. Precision farming helps farmers to use inputs such as fertilizers, pesticides and water more efficiently. Like agro-ecological approaches, precision farming ensures sustainability. Biotechnology will play an important role in all the following six major components of integrated natural resource management and precision farming:

- Integrated Gene Management
- Efficient Water Management
- Integrated Nutrient Supply
- Soil Health Care
- Integrated Pest Management
- Efficient Post-Harvest Management

Eco-technology based precision farming can help cut costs, enhance marketable surplus and eliminate ecological risks.

4.2 Fisheries

Marine and aquatic ecosystems includes a range of diversity - wetlands, mangroves and coral reefs which besides being one of the most important and productive sources of food, protein, and livelihood for a large number of people of the country are an extremely rich repository of both floral and faunal diversity. Unfortunately, these very ecosystems are today under severe threat from industrial and technological advances including intensified fishing technologies, aquaculture, oil explorations and effluent discharge.

4.2.1 Mechanized Fishing

Following independence, India in its attempt to build its economy encouraged and promoted modernized western fishing technologies like bottom trawling and purse seining for large scale harvesting of fish, in total ignorance of the skills and potentials of a large number of traditional fisherfolk. India with its 7500 km coastline and innumerable rivers, lagoons, lakes, reservoirs and ponds has one of the largest populations of fisher people over 12 million with two thirds depending on marine fishing and the remaining on fishing in a variety of inland water bodies.

India's estimated marine resources potential is 3.9 million tonnes. In 1988, There were 2.3 lakh traditional crafts, 0.40 lakh traditional motorized crafts and 0.51 lakh mechanized boats operating in Indian waters.

Ever since, the population of traditional fishermen has increased by more than 20.8% while the average production of each fishermen declined by more than half resulting in 98.5% of the fishermen population descending below poverty line. The traditional fishermen who constitute almost 89% of the total fisherfolk community caught a negligible quantity of fish. However, the small number of mechanized fish gear operators have been taking away the bulk of the catch (>92%) thus adversely impacting the lives and economy of traditional fishermen in the country. To meet the highly competitive international market demand the mechanized operators have been employing various unsustainable means of fishing – including seines, stake nets, lines, bag nets, encircling nets and lift nets which has resulted he marine biological diversity of the oceans are threatened.

Trawling destroys sea bed habitats particularly adversely affecting the including sea grasses and marine fauna such as the highly endangered dugongs and sea turtle habitats. Trawling and use of nylon mesh nets also results in the entanglement of marine turtles and dugongs resulting in high incidences of turtle mortality. Rising demand and decreasing stocks have led to increased mechanization, over-capitalization of the industry and the buildup of excessive fishing fleets, particularly of the larger-scale fishing vessels that are responsible for the bulk of overfishing related problems worldwide.

The use of dynamite to kill fish and toxic chemicals to capture either live or dead fish is a common practice in artisanal fisheries. The industry subsector has often employed very effective but destructive fishing gear and techniques. An example is the use of large-scale pelagic driftnets in the high seas, which also kill many juvenile fish and non target species including marine mammals.

Industrial effluents dishcarge

The oceans and all water bodies are the global sinks for many pollutants from both land-based (e.g., mine tailings, untreated domestic effluents, and sediments from soil erosion) and water-based (e.g., oil spills and waste from shipping) industries. Almost all forms of water pollutants diminish the capacity of water bodies to support aquatic life if they reduce the amount of dissolved oxygen. Chemicals in polluted waters also affect fish populations adversely. The contamination of aquatic species with pollutants, primarily with sewage and toxic substances, and the occurrence of toxic algae blooms have also rendered them unfit for human consumption.

Industrial Impacts on the fragile ecosystem of of Gulf of Mannar

Gulf of Mannar Shipping channel threatens dugongs, dolphins and sea turtles

The Gulf of Mannar Marine Reserve is threatened by shipping canal project that will disturb the delicate marine ecosystem of the area with its seagrasses, corals, mangroves, turtles and highly endangered dugongs. The communities that depend on the Gulf will also be severely hit due to the ecological degradation. A Rs. 1,200 crore Sethu Samudram Ship Canal Projct on the coast of Tamil Nadu is under consideration by the central and state government. It entails dedging of a canal to enable faster sea travel between the east and west coasts to prevent ships having to sail 700 miles around Sri Lanka

Nearly 50,000 people living in 138 villages and towns spread over five districts rely indirectly on the fishery resources of the waters of the Gulf for their livelihoods. The construction project is expected to destroy the unique and fragile marine ecology of the area through constant dredging churning of sediment will also smother the coral reefs. The increase in shipping traffic also poses increasing threats by possible oil spills and marine pollution. The areas is already under stress from industries along the Tamil Nadu coast. Ash and effluents from the Tuticorin Thermal Power Satation the Dhrangadhra Chemical works and the Tuticorin Salt Marine Chemicals is already polluting the Gulf.

Gulf of Mannar, India's first marine biosphere reserve is one of India's most biologically diverse coastal regions. Over 3,600 species of plants and animals exist in the areas in a combination of different ecosystems including mangroves, sea grassses and coral reefs. The region is believed to have the highest concentration of seagrass species along India" coast with six of the world's twelve seagrass genera and 11 of the worl's 50 seagrass species occuring here. These beds are of global significance as they are among the largest remaining feeding grounds for the globally endangered dugong *Dugon dugong*. Additionally five species of marine turtles, innumerable fish, molluscs and crustaceans also feed here. The region has been identified as "special concern" by the IUCN, UNEP, UNESCO and WWF based on its threatened status and richness of biological wealth.

Source: BNHS

4.2.2 Aquaculture

In just the last fifteen years, shrimp aquaculture has been transformed from the traditional endeavor of peasant farmers in China and Southeast Asia into a US$6 billion global business. Today industrial shrimp aquaculture has spread to 50 countries. Shrimp farms have destroyed a million hectares of critical coastal wetlands -- including mangrove forests -- worldwide, disrupted and displaced traditional fishing communities, and contaminated freshwater supplies. As a result, there has been social conflict, human rights abuses, and violence. In Bangladesh, for example, around 100 people have been killed in clashes over industrial shrimp farming.

The expansion of industrial shrimp farming in India has been driven by soaring demand for shrimp in the United States, Canada, Japan, and Europe. Shrimp trawling is considered to be one of the world's most wasteful and harmful fishing practices.

Intensive farming in ponds, pens, or cages produces organic matter that settles to the bottom of the pond or pen, or below the cages. Some of the suspended waste matter from excessive artificial feeding, fish excreta, and the application of chemicals is flushed out of the enclosures and pollutes adjacent waterways.

4.3 Forestry

The forests of India are a critical resource for the subsistence of rural peoples throughout the country, but especially in hill and mountain areas, both because of their direct provision of food, fuel and fodder and because of their role in stabilizing soil and water resources. Due to the use of these forests for commerce and industry, the flora and fauna of the region is deteriorating very fast. Compared to 1970s, India has been quite successful in cutting down the rate of deforestation and somewhat stabilizing the forest cover during the 1980s and 1990s. But India's forests still face major challenges and threats mainly due to the increased population and industrialization. India has a dense forest cover of only 12%. This is much less than the goal of having 33% forest cover as enunciated in the national forest policy of 1952 and 1988. India's forest cover has diminished from 63.89 mha in 1995 to 63.34 mha in 1997.

4.3.1 Commercial Plantations

The FAO assessment shows that in 1990 India had a forest cover of 70.63 mha, of which 51.73 mha were natural forests and 18.90 mha under plantations. A similar FAO study shows that during 1980 India had a forest cover of 60.41 mha, of which natural forests were 57.23 mha and plantations were 3.18 mha. So, according to this assessment country's tree cover went up by more than 10 mha. This shows that there has been decrease in the natural forest cover of the country. The increase in the forest cover is mainly because of the plantations. The FAO report points out that India has the world's largest area under the plantations. The total plantation area reported by 90 countries of the tropical zone amounted to 30.66 mha in 1990. Of this India alone had 13.23 mha or 43% of the tropical world's total. This shows that there has been decrease in the biodiversity of the forest ecosystem. In order to meet the growing demand for the fodder and fuel there has been more focus on the plantations (mainly exotic species) with reduced rotation period. On one hand this has been successful in meeting the local needs and the industrial requirements while on the other hand it has been reducing the biodiversity.

4.3.2 Forest Logging

Forest logging has also an adverse impact on the biodiversity. Logging considerably reduces biomass availability. This has resulted in the increased pressure by the people on the forests to meet their needs for fuel and fodder. This has affected the natural regeneration of the forests. However due to the ban on clear felling the logging has been reduced and the selection felling is being followed. The plantations meet most of the requirements for the industries and the pressure on the natural forest is reduced.

4.3.3 Shifting Cultivation

Shifting cultivation is practiced in many parts of India particularly North East India. Once considered to be the eco friendly agriculture practice, jhum has been reducing the biodiversity. The constant growth in the hillside population has resulted in the reduced jhum cycle. During the earlier days the jhum cycle used to be 10-15 years which now has been reduced to 2-5 years. The reduced jhum cycle has affected the regeneration of the forests. In some of the cases the forest land is being used for permanent agriculture. This has resulted in the forest fragmentation and loss of biodiversity. Alternative farming systems to replace the traditional jhum has been started in Meghalaya. However, there has not been much success in this regard. This requires studying jhum more closely and involving the local communities before the practice is condemned and replaced. Alternatives like watershed-based farming with livestock rearing and planting of indigenous tree species should be adopted. Other practices like agro-forestry and horticulture should be promoted so that the people can find the alternatives for the traditional jhum. Technologies that increase productivity or reduce the costs of conservation practices and good market prices for farm products can encourage land improvement.

4.3.4 Recycled Paper

The majority (63.4%) of the paper mills in India use not wood or agro-residue, but waste paper as raw material. However, some of the industries have started using agro-residue for the paper production. With less energy consumption and waste generation than wood based mills, a high ratio of production and less chemical consumption, recycling mills make good business and environmental sense. Most important of all, they do not extract the raw material directly from the forests. All that is required is an efficient system of recovering waste paper. However, such a strong system does not exists in India. Due to this reason paper recycling mills in India are heading towards a raw material crisis.

But waste paper is a clean alternative and policies need to be formulated to increase its use. Recycled fiber is particularly ideal for making paper and paper board for the packaging industry and for newsprint. The potential of reusing waste paper is evident from the fact that mills in South Korea and Taiwan are entirely dependent on waste paper as a raw material.

4.3.5 Non-Timber Forest Produce (NTFP)

In India where economy is largely based on rain-fed agriculture, people rely on non agricultural or forest vegetation for subsistence during lean periods. The collection of NTFP changes with the seasons. Harvesting of NTFP is usually suspended during the monsoon when people are fully engaged in the field for ploughing and sowing the crops. Womenfolk constitutes the major gatherers of forest produce. While medicine plants are by and large collected by a few knowledgeable men, all food and fuel items and material for preparing household articles both for domestic and market consumption are always collected by women. Often these are collected as a household activity. A household or non-household cottage industry may also be involved in processing of NTFPs by applying local skills and village level technology.

4.3.6 Community Gene Management

Both in situ on-farm conservation of intra-specific variability, particularly in plants of food and medicinal value and ex situ on-farm conservation through sacred groves have been part of the cultural traditions of rural and tribal families in India. Sacred groves are considered to be the climax formations representing the original diverse floral and faunal species. By giving explicit recognition to the pivotal role of community conservation in strengthening ecological, food and health security systems we can succeed in revitalizing these old traditions. In national integrated gene management systems, in situ, ex situ and community conservation methods should receive adequate and concurrent attention and support. However, due to the increasing population pressure the sacred groves are being encroached for agriculture, resulting in the loss of biological diversity.

4.4. Mining

Total mineralized area for coal, lignite, major and minor minerals have been estimated to be around 31,000 km^2 in the country. The process of economic and social development of a country always involves industrialization, which in turn is linked with core sector growth. It is more so in a developing country like India where overall growth rate in GDP is envisaged around 7%. The growth rate on industrial sector though planned for higher growth, has slipped to 6.6% in 1996-97 the overall growth in real GDP was around 6.8%. The economic survey of Government of India for 1997-98 has indicated a growth rate of 5%.

Although development projects in general have had an adverse impact on the displaced persons, the mining projects in particular have grave implications for the oustees as well as the people inhabiting the neighborhood. It has become imperative therefore to analyze the diverse and adverse impact of mining on biodiversity and the people who are displaced or going to be displaced.

The exploitation of mineral resources through open cast or strip and underground mining, be it coal for the generation of energy, iron ore for export and the growth of the national steel industry, bauxite for feeding the Japanese aluminum plants, or limestone for the cement industry- exploitation of mineral resources is the material basis of the industrial economy, has caused wide ranging environmental problems such as land degradation, loss of biological wealth, air, water and noise pollution and displacement of local communities.

The Doon valley is a distinct ecobiome in the district of Dehradun, situated in the Himalayan foothills of the state of Uttaranchal. Recently, it has become the focus of a serious conflict over the mode of utilization of the rich limestone deposits located in the Mussoorie Hills, which form the northern boundary of the Valley. For one interest group, the most productive use of the limestone deposits in the Valley lies in their extraction for commercial and industrial use. For the other and much larger interest group (consisting of the local communities, both rural and urban), the most productive use of the same limestone deposits lies in their in situ function in conserving the large volumes of rain water that falls in the Mussoorie Hills during the monsoon every year.

For the people residing in the Valley, this growth has threatened the material basis of survival through the destructive impact of the limestone industry on the hydrological balance of the Valley. Damage to vital resources such as water, through the destruction of the essential ecological processes controlling the hydrological balance of the Valley, has been perceived by the people as a violation of their political and economic right to a decent though often minimal share of the vital resources that are needed for their biological and economic sustenance.

Kudremukh Iron Ore Company (KIOCL) has been operating in the Aroli and Malleshwara regions of Kudremukh National Park, under a 30-year lease, which expired in July 1999. Since then, the company tried to obtain a 20-year extension on the lease, but it has only been granted two successive yearlong temporary permits. The work permit given to the KIOCL to continue the extraction of iron in the Kudremukh National Park, Karnataka. Impacts of mining in the area are apparent. According to a report by Environment Support Group (ESG) many fish varieties have disappeared due to pollution and agricultural productivity decline. River pollution has provoked an increase in cases of disease among villagers.

The multiplier effect of mining in a region has acted as a catalyst for urbanization and industrialization. Whether it is iron ore in Goa or Karnataka, bauxite in the hills of Madhya Pradesh or Orissa, coal in the nation's energy capital Singrauli, limestone in the Doon Valley or magnetite in Kumaon, open cast mining on catchment slopes has drastically reduced the water resources and biological diversity of the country. Mining increases surface run-off and decreases infiltration. The increased run-off combined with the choking of water courses with overburdens and fines are causing floods and droughts in regions-which had stable and perennial supplies of water.

The development of infrastructure and core sector is directly linked with increased production of minerals, like coal for power sector, iron ore for steel sector, limestone for cement for housing and infrastructure development. This is more so in open cast mining technology, which is adopted for quick and economic extraction with higher percentage of recovery. During 1997-98, entire 106 million tonnes of limestone, 70 million tonnes of iron ore, 6 million tonnes of bauxite, 23 million tonnes of lignite, 78% of coal production came only from open cast mines. Coal based power plants supply 70% of electricity in the country, consuming more than 200 Mt which may go up to 400 Mt in 2010. It is estimated that during 1997-98 about 1300 million tonnes overburden and waste material had to be removed, while extracting about 500 million tonnes of solid minerals. Naturally, this excavation will have an impact on the diversity of the region. Associated with the production of minerals and stacking of waste, there are problems of air and water pollution, noise, vibration, subsidence, effect on flora and fauna, loss of top soil *etc.* and lastly, the most important one is the resettlement and rehabilitation of land owners and social mitigation measure.

5. Eco - Technologies

The successful adoption of alternative eco - friendly technologies depends upon their integration into the existing livelihood systems. Rural people are both the experimenters with and potential beneficiaries of alternative systems. However, given the diverse environmental, economic and social conditions in the areas, not all strategies are applicable universally. Hence, development activities that work with and through indigenous knowledge and organizational structures have advantages. Much of the biological diversity is in the custody of farmers who follow age-old farming and landuse practices. Hence they are the excellent conservators of biodiversity. However, due to the increasing demand for food, fodder and other natural resources there is a need to develop the eco-technologies (as they are the blend of traditional knowledge and modern technologies).

5.1 Community/Household Level (Case Studies)

The Watershed Development and Soil Conservation Department of the Government of Rajasthan has facilitated the formation of 15,000 watershed users groups, with at least three million hectares under sustainable practices, such as strips of vetiver and other grasses on the contour and regeneration of common lands with shrubs and trees. Sorghum and millet yield has more than doubled to 400-875 Kg./ha (without addition of fertilizers); and grass strips have improved yields by 50-200% to 450-925 Kg./ha.

The Sikar district of Rajasthan is dry (annual rainfall is 25-50 cm.) so establishing the trees is very difficult. People grow pearl millet, pulses, sorghum in the monsoon and wheat, chilly, gram, onion, fennel, cummins and fenugreek in the winters on the irrigated plots. In 1978-79, the Forest Department of Rajasthan launched a tree-planting scheme on irrigated lands. People planted the seedlings on irrigated and the dryland. The survival rate on the dryland was very low (10-15%). After a training course at Indian Agricultural Research Institute (IARI), people started experiments to establish trees on the dryland. They found that below the depth of 30 cm. Soil has sufficient moisture for the survival of plants provided evapo transpiration was controlled by removing the weeds. In 1983, towards the end of monsoon they planted *Dalbergia sissoo*, *Zizyphus* spp., *Acacia nilotica* and *Ailanthus excelsa*. The success rate was more than 90%. Several officials, social workers and foresters *etc.* visited the village and appreciated their efforts and predicted a possibility of another green revolution in dry lands, provided the technology is scaled up.

The National Innovation Foundation has been set-up with the aim to recognize and support creative potential of innovators at the grassroots level as a way to make India self-reliant and a leader in sustainable technologies. The first competition was held in 2000. One of the prize winners in the first international competition, organized by the International Fund for Agriculture Development, was Maniam Sitaraman who developed a biological control of the rice hispa pest (*Dicladispa armigera*). It causes immense losses of yield in South ands South East Asia. Maniam Sitaraman, a tribal farmer from Andhra Pradesh in India, uses a poisonous plant called 'kodisa' (*Cleistanthus collinus*) found in abundance all along the Eastern Ghats.

Alarmed by heavy soil erosion and land degradation in the Shiwaliks, the Punjab government decided to construct check dams and carry out cathchment area treatment on the pattern of Sukhomajiri. Nada (village in Ropar district, Punjab) was chosen after a detailed soil, land and socio-economic survey of the area. Before the project started the villagers agreed to participate social fencing and stopped taking their animals, mainly goats to the forest for grazing. The hilly catchment area of 125 ha was severely denuded. A massive afforestation programme was undertaken by the forest department the local communities. To reduce the burden of grazing on the forest, an exchange scheme sponsored by the World Bank and implemented by the animal husbandry was extended to the farmers. A major benefit came by the increased foodgrain production. The impact on the village life was visible. There is an increase in the household income and the pressure on the forests has been reduced.

With the setting up of the community biogas plant (under an ICAR sponsored all India Coordinated Research Project, the scenario at Islampur village in Bhopal changed. About 21 quintals of cowdung thoroughly mixed with an equal quantity of water is fed into the plant everyday. The gas yield has been reportedly varying from 45-67m3 per day depending on the season. The gas is supplied to the local people for domestic cooking twice a day that is equivalent to saving 112 tonnes of fuelwood/agro-residues per day while the digested slurry is used for cultivation.

Extensive field trials revealed that about 50% of the recommended dose of inorganic fertilizer can be replaced by biogas slurry without significantly affecting the crop yields. Besides application of the spent slurry along with inorganic fertilizers resulted in better soil health. Thus the plants have been helping conserve precious forest and chemical fertilizers and reduce pressure on the environment.

5.2 Industrial Level (Case Studies)

5.2.1 Technologies for improving grain yields

New technologies that help conserve agricultural resources in rice and wheat cultivation has been evolved by the Rice-Wheat Consortium (RWC). RWC is a collaborative body which is the outcome of the heads of the premier of agricultural bodies of Bangladesh, Nepal, India and Pakistan. Deterioration of soil quality and water depletion, among other things has resulted in decline in yields. The Consortium's thrust is to promote different technologies that help conserve the resources and which are economically and environmentally advantageous. RWC has promoted surface seeding, zero tillage, reduced tillage and bed planting, collectively called resource conservation technologies (RCT) with potential multiple benefits for the user.

In the surface seeding - method the seed is place on top of the soil surface without any land preparation such as tilling. The process helps contain soil erosion and does away with the costs of tilling. The practice has been promoted in eastern parts of India and the low-lying lands of Nepal.

In zero tilling system - on the other hand, the seed is placed in the soil by a seed drill with limited prior land preparation. The tilling And soil preparation is carried out only in the rows where seeds are to be sown and not the entire piece of land under cultivation.

This technology has been promoted in the higher yield, relatively more mechanized areas of India and Pakistan. The results of adoption of technologies have been encouraging in Haryana and Punjab in Pakistan. Farmers in Haryana user zero tilling method on 8000 ha of soil and direct drilling with locally manufactured drills was used to cultivate 5000 ha in Punjab, Pakistan. The area under zero tillage has increased three-fold in the last three years and should continue to expand, as the equipment becomes easily available to the farmers. According to ICAR the farmers have saved about Rs. 2000/- per hectare, reduced irrigation requirements by 30-5-% , advancement of sowing time, lower prevalence of weeds and increase in yield by 200-600 kg per hectare. The advancement of sowing time is crucial as it enhances the yield and provides scope for an extra crop and also helps the farmer retain casual labour at the farm, which reduces the cost of tilling.

5.2.2 Biofertilizers and Rice Production

Nitrogen fixing micro-organisms convert about 139-170 million tonnes of nitrogen every year into fertilizer nitrogen for which the energy bill is paid by the nature. The fact that the total world biological nitrogen fixation is three times that of industrially produced nitrogen, demonstrates the significance of biological nitrogen fixation in agricultural and nitrogen cycles. Nitrogen fixing systems offer an economically attractive and ecologically sound means of reducing external inputs and improving internal resources.

Immobilization of nitrogen fixing cyanobacteria under rice field conditions can be done with solid matrices such as polyurethane foam, polyvinyl foam, sugar cane waste, paper waste and rice husk. The immobilised cyanobacteria could continuously excrete the ammonia extracellularly which could be used for continuous supply of nitrogen to rice crop. The immobilised cyanobacterial system in solid matrix when inoculated in rice field is like a mini in situ fertilizer factory which produces ammonia continuously. The accumulation of ammoniacal nitrogen in the flood water as a result of immobilised cyanobacterial inoculation will reflect on the growth and yield of rice.

5.2.3 New Mining Technology for Mining

The process of open-cast mining scars the landscape, disrupts ecosystems and destroys microbial communities. Apart from unsightly impacts, the degraded environments created in the aftermath of open-cast mining often cannot support biomass development. Put another way, extensively mined land usually does not possess sufficient surface soil to anchor plants, and the plant growth that does take place is inhibited by the presence of toxic metals. Over the long term, open-cast mining reduces forest productivity, damages aquatic and atmospheric ecosystems and sometimes leads to substantial alterations in microclimates. Such changes, in turn, carry adverse economic and social impacts for nearby communities whose residents depend on the region's natural resources for large portions of their incomes.

The National Environmental Engineering Research Institute (NEERI), Nagpur, India, has developed a sustainable eco-friendly technology that reclaims and rejuvenates the "soil spoils" left behind by open-cast mining. The strategy, which experts have labeled the integrated biotechnological approach (IBA), involves the use of diverse organic materials (for example, such industrial wastes as pressmud, a by-product of sugar mills, and treated sludge, a by-product of paper mills) to build soil productivity. These organic materials, which nourish the depleted soil, are supplemented by the planting of saplings that contain specialized cultures of endomycorrhizal fungi and such nitrogen-fixing bacteria as *Rhizobium* and *Azotobacter*. IBA has increased the survival rate of plant species found on land that is scarred by open-cast mining to more than 80 percent. At the same time, it has boosted the species' growth rate by a factor of five. Barren, eroded slopes – hard rock of a deep brown color – have been transformed into lush-green tree-lined environments. Equally important, the areas' biodiversity is slowly being regenerated. In fact, IBA forests ultimately produce commodities of high value, including timber, fruit and gum. In addition to these long-term environmental benefits, over the short term the strategy generates jobs and income.

5.2.4 Application of Remote Sensing and GIS in Biodiversity Conservation

Tropical deforestation and the loss of biological diversity have raised major concern among ecologists during the recent years. The loss of biodiversity has been attributed to the destruction of habitat, isolation of fragments of formely contiguous habitats and edge effects within a boundary zone between forest and deforested areas. A Geographic Information System (GIS) has been used to spatially model the disturbance regimes and to integrate the ground based non-spatial data with the spatial characters of the landscape. The various parameters (viz. Patch shape, patch size, number of patches, porosity, fragmentation and juxtaposition) have been analyzed on the landcover maps to spatially represent the disturbance regimes. A spatial model incorporating ground based biodiversity attributes of the landscape elements, landuse change patterns, disturbance regimes of the landscape and terrain complexity have been used to delineate the spatial pattern of the biological diversity. Habitat evaluation using ground based data and their spatial organization have been found to provide the reliable information on the biodiversity distribution pattern. The present approach for prioritizing the biodiversity rich sites have the advantage of integrating spatial, non spatial information and horizontal relationships. The approach will facilitate conservation prioritization, systematic inventory and continuous monitoring. The project is jointly funded by Department of Space and Department Biotechnology for Biodiversity Characterization at National Level and is being executed by Indian Institute of Remote Sensing (IIRS), Department of Space, Dehradun.

However, there is need to prepare detailed plan on GIS and maps should be prepared jointly by local communities and professionals to foster an integrated approach to forest conservation and sustainable and equitable use to meet the following needs:

- Conservation of prime forests
- Commercial forestry to meet the needs of small and large industries
- Community forestry to meet the fuel wood, fodder, fiber, fruits and other needs of local communities
- Zoning and identification of industrial sited with minimum impact on biodiversity

5.2.5 Turtle Excluding Devices (TEDs)

A TED is a fishing gear device, which is inserted into an existing trawl and functions as an escape hatch to allow turtles that are caught up in a trawl net to be released and at the same time, releasing a significant amount of intended catch. Slanted bars guide sea turtles and other large objects out of a net through a trap door, while smaller fish swim through the bars on the device to escape the net. Early TEDs excluded 97% of the entrapped sea turtles, retained most shrimp, increased trawling efficiency, and reduced finfish catch by 50-60% as well. They were heavy, however, and proved unwieldy and undesirable for most shrimp fishers. By the late 1980s, a lightweight, collapsible TED had been developed, spurred by laws in some states requiring the used of TEDs.

There has been a growing international acceptance of the use of TEDs. Some foreign governments have shown an interest in acquiring TED technology and in developing national TED programs. The U.S Department of State and the National Marine Fisheries Service have worked to provide training in the use of TEDs, and to promote the transfer of TEDs technology. Orissa is the first state in India to get TED technology, to reduce turtle casualty and unintended catch during fishing by trawlers.

6. Ways Forward for the Country

Technological and Industrial developments are essential and important for the economy as well as livelihoods. However, there is a need for environmental consciousness and responsibility through action. There is a need for spreading awareness, promotion and revival of certain traditional "practices" and promoting measures, which could mitigate the impact of the technological developments. Existing environment friendly technologies are few, but require to be researched, field-tested, promoted and disseminated on a large scale

Many policies have focused too narrowly on short term solutions rather than on long term sustainable methods that maximize local resources. In most of the cases the better results come from using indigenous knowledge and science to build on traditional farming systems, better use of local renewable resources and external inputs; by greater collaboration of farmers and development agencies and more access to credit. For a long term sustainable and traditional solutions to development have been shunned by many of the donor organizations and agencies. It is the time for them to adjust their policies and adopt the sustainable revolution and evolution.

The NGOs play an important role by providing a window on the real world for the biological conservation. NGOs can assist in the process of identifying knowledge needs because they are often in a position to listen to the needs of stakeholders and policymakers more directly than the scientist. Also they can assist in identifying the local innovations that can be refined and can be used at a larger scale.

Both in situ and ex situ conservation has been part of cultural tradition in India. However, the tradition has been drying out in the country. In national integrated gene management these conservation methods should receive adequate and concurrent attention and support.

By providing explicit recognition to the pivotal role of community conservation will be strengthened in revitalizing these traditions.

There is need to develop more environmentally and socially friendly tourism in the country. Ecotourism aims at promoting purposeful travel to natural areas to understand the culture and history of the environment, taking care not to alter the integrity of the ecosystem, while producing economic opportunities that make conservation of natural resources beneficial to local people. Hence promotion of low impact, ecological tourism will be able to avoid the adverse environmental effects of traditional tourism. Similarly food processing is the area where traditional knowledge needs to be integrated with the technology for the sustainable livelihood of the people.

Eco-technologies enable the adoption of ISO 9000 and ISO 14000 standards of environmental management. Building technical competence and providing institutional incentives for conservation of diversity have to go hand in hand. Much of the technologies for conservation or accessing or value addition in biodiversity may require an optimal combination of institutional structures and incentive measures. In past, incentives without institutions led to excessive biodiversity extraction. Large number of companies even in the ayurvedic drug sector pursued their business without any self-regulation or institutional constraints. The future gain in technology depends to a great extent on the way information technology is applied. Unless networked information system exists, best use of diversity may not be possible.

Biodiversity Conservation and Sustainable Tourism
In India's Western Trans-Himalayas

Some Key Issues Facing Recently Opened Tourist Destinations and Biodiversity Hot Spots in the Indian Chang Tang of Ladakh

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Paper presented at the Biodiversity & Sustainable Tourism Workshop
Organised by WWF-India and LEDeG

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Introduction

Local people living in the Tso Morari area have identified some key issues of concern regarding tourism development and its impact in their region during a workshop held in Korzok in August and in the introduction to the current workshop. I would like to follow in their wake with some observations on the changes having taken place there since the area was first opened to outside visitors 8 years ago and the growing threats to the integrity of these fragile ecosystems. I will conclude by underlining some of the major issues mentioned by them as also opportunities and possible solutions to tackle them, which are proposed for discussion.

I first travelled to Ladakh in the summer of 1996 from the neighbouring Spit valley in Himachal Pradesh. The region, known as Rupsho is part of the Indian Chang Tang, then recently opened to tourism. We were perhaps a couple of hundreds to have taken this opportunity, travelling in mid-summer with a few pack animals from Spiti or by jeep from Manali or Leh. We were stunned by the pristine environment, rich traditions of the local inhabitants and the diversity of birds and other wildlife. We did a first census of waterfowl and were amazed to find over 800 Bar-headed geese, a breeding colony of c. 300 Brown-headed gulls, over 100 Brahminy ducks and 3 individuals of the endangered Black-necked cranes around Tso Morari alone. There was hardly any road in and around Korzok, no established campsite nor guesthouse so we camped in rich meadows below the monastery with Spiti horsemen and traders.