

***Biodiversity Conservation - The Impact of Society on Technology and Technological Developments on Its Physical Environment**

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The Framework - Every Society has evolved a certain Philosophical framework under which developments have taken place in its social, economic or physical aspects. Obviously, these philosophical foundations have governed not only the inter-relations amongst people in a society but also between man and his environment, the plants, animals and all other biota as well as non-living resources viz. minerals, water and so on. On the other hand, the philosophical foundations in any society are also bound to be governed by the physical environment around it, while several of these foundations had also evolved to tackle the challenges of the then prevalent physical environments in those societies.

Thus, most of the biological diversity rich regions of Asia, Africa & Latin America had evolved philosophical frameworks which advocated man's harmony with its nature, while utilizing its natural resources. It is also likely that they developed only such technologies, which ensured harmony with nature and, therefore, these regions could retain rich biological diversity over millennia. It is also likely that the civilizations in Europe and Middle East, because of their adverse climatic conditions and environment, evolved philosophical frameworks, which believed in conquering nature and hence other people, to enable exploitation of their natural resources.

While these philosophical issues may be a matter of debate for epistemologists, it is well known that the traditional Indian civilization strongly believed in harmonious relationship with nature while it did encourage physical, economic and social affluence. Thus, the dictum of '*Yat Pinde Tat Brahmande*' is a unique concept of Indian philosophy, which means that human body is a miniaturized reflection of the cosmos. It would obviously mean that unduly exploiting nature will also adversely affect the human body.

Also, the ultimate objective of human endeavour has been to attain 'Moksha' which is to be in unison with 'Nature', the almighty. Even at a physical level it is expected that 'Development' should be 'Mangalmaya' which means overall development of the person, not only enriching his physical assets through skills but also valour, piousness and better understanding of the society, the environment and its philosophical foundations.

This can also be seen for example in the holistic definition of Health as propounded by Maharshi Sushrut "*Samdosha, Samagnischa, Samadhatu Malakriyah-Prasannatmendriyah Manah Swastha-ityabhidiyate*. Thus, a healthy person must have complete equilibrium in his *Doshas* (Body humours), *Agni* (Digestive power)" and *Dhatus* (Body constituents), besides the fact that he should be 'happy' not only through his *Indriyas* (Sense organs) but also through his Mana (Mind-intellect) and Atma (spiritually). Such a broad and holistic definition of a healthy person, given more than 5000 years ago, is not found in any other civilization, also indicating its emphasis on the equilibrium between physical as well as intellectual/ecological accomplishments. Yet another important dictum propounded by Charaka was "Yaddeshasya Yo jantuhu tad deshasya tasyaoushadham" which meant that diseases found in a region in a region can be cured by plants found in that region. This philosophy was also, to encourage the use of locally available medicinal plants for health care and treatment of diseases.

This approach to life evolved from the Vedic Philosophy which pervaded all walks of life in the Indian Society till the emergence of British rule. Thus, while agriculture was the mainstay of Indian civilization since Harappan period, it was based on giving mutual reverence to nature and the mother earth as described in the Bhoomi Sukta (Earth hymns) in the Vedas. Since the Bhomi Sukta espouses the relationship between earth and man as that between a mother and son, it is expected that she will be revered by human beings for she is the bestower of our food, water and air, the three most important constituents for survival. Thus, throughout the evolution of Indian philosophy, not only the earth but also her various constituents and products viz. the rivers, lakes, oceans & ponds, mountains, forests, birds, animals and vegetation are all deified. Since 'mother earth' was treated as sacred, the ultimate God '*Brahm*' was expected to be present in all the living (Chetan) as well as non-living (Jad) entities found on this planet, advising people to draw only as much from the mother earth as was necessary to ensure '*Ubhay*

Samridhi – the mutual well-being and prosperity. This also ensured that natural habitats were not disturbed and hence biodiversity was largely conserved. It has been reported in a study by COMPAS that many agri-centred and biodiversity rich civilizations across the globe had a similar worldview with concepts like mother earth and sacred mountains, rivers, trees and animals. The sacred character of nature helped in its conservation and thereby that of its biodiversity.

Historical Developments in Technology and Their Impact

Historically, man developed technologies to fulfill its primary needs of food, nutrition & health; clothing; housing and habitat; water & energy and transport. Besides, the need for self-protection or to have control over resources of others led to development of defence technologies. In the entire process several handicrafts and artisanal technologies were also developed till the industrial revolution in Europe in the seventeenth century developed technologies which required large-scale utilization of natural resources, disturbing natural habitats in proportions which were never conceivable in the human history. The industrial revolution also helped in large-scale development of armament technology which helped in the spread of colonialism to exploit the natural resources of all continents at unprecedented levels.

A study in 1986 by IUCN found that 65 percent of original ecosystems south of Sahara have been subject to major ecological disturbance, and for south East Asia, 67 percent of natural habitat has been lost. While the percentage of natural habitat loss in Western Europe has been even higher, it may not have caused as severe losses in biodiversity. The Species Survival Commission of the IUCN had estimated that over exploitation of plant and animal species has been a decisive factor in the impending extinction of two out of five threatened vertebrate species.

Introduction of exotic species in any ecosystem also often causes destruction of indigenous species. Roughly half the extinctions of island bird species have been due to the introduction of exotic mammals while goats and other herbivores are reported to have devastated whole island ecosystems. Exotic plant species have been regarded as the major threat to the US National Parks system (Mc Neely et al., 1990). Biologists such as

Daniel Janzen (1986) fear that the release of genetically modified organism may lead to extinction catastrophes of unprecedented dimensions.

Traditional Indian agricultural practice always ensured that productivity of the land does not decrease and hence encouraged the use of biological methods of manuring, bio-insecticides and pesticides. Traditional agricultural technologies are still practiced by a very large proportion of Indian farmers. The traditional institution of Panchayat as well as Yajmans (through a barter system) ensured that a balance is maintained amongst interests of various sections of rural society while enriching the agriculture and maintaining ecological balance. This also ensured conservation of biodiversity over millennia.

Large-scale use of Chemical fertilizers, insecticides, pesticides, tropospheric ozone, sulphur, nitrogen oxides and other chemicals has caused massive degradation of natural systems and endangerment of species. These toxic chemicals initially lead to lowering in the numbers of individuals within species due to loss of suitable habitat, which eventually declines rather rapidly (LOLF, 1986). The large-scale denudation of forests to provide feedstock to the industries or to develop agribusiness to grow export or cash crops has resulted in loss of natural habitat causing massive damages to biodiversity. On the contrary, when the tribals, farmers or artisans used to cut trees from the forest for their use, their traditions ensured that it did not disturb ecological balance lest it does 'Anisht' or bring ill luck to them. In fact planting of various trees was mandatory in all the human habitations, let alone the religious places or 'Devarayas' which have preserved a vast variety of fauna and flora in different parts of the country, in different geo-climatic conditions. Similarly, adequate efforts were always made to ensure protection of all living beings around us. In India we have a traditions of feeding animals, birds and even insects on various religious occasions or on a regular basis. It was propounded to be pious to grow trees to give shelter to various life forms.

Though we have a very long tradition of rural industries where our significant population was involved in a large number of activities concerning agriculture, health, clothing, housing, transport and other areas mentioned earlier, in all these cases our emphasis has been on using technologies which ensured a harmonious relationship with nature thereby

contributing to conservation of biological diversity. We shall discuss these sectors in the following paragraphs.

Agriculture: While the study of plant life in India can be traced back to Rigveda and Atharvaveda (~6000 B.C.), the three major texts covering Vrikshayurveda (Science of plant life) were by Varahmihira, Kautilya and Sarangdhara. These covered areas ranging from collection, selection and storage of seeds, their germination, sowing and methods of plant propagation, grafting, nursing and irrigation, testing and classification of soils useful for various types of plants or crops; manuring; pest & disease management, preventive and promotive care to build up disease resistance and to cultivate healthy plants; taxonomy and classification to suit various purposes, meteorological conditions for various plants and use of plants as indicators of weather, water & minerals etc. The depth and broad coverage of various aspects ensured that the productivity of soil was maintained through millennia with emphasis on balanced relationship with nature for conservation of biological diversity. It was as late as in 1950 that more than 20,000 varieties of rice were cultivated in Bastar alone. All the above-mentioned aspects involved natural products and hence the enrichment of nature was a primary focus in agriculture as against the major focus on economic benefit in the contemporary western agriculture, which is being conducted in an industrial manner.

The shifting cultivation is still practiced not only in certain parts of India but also in other parts of South-East Asia, Africa and Latin America. The system of leaving the land fallow for a certain period not only helps in the regeneration of the soil fertility but also the biodiversity in the land. Mixed cropping and crop diversity and rotation has been practiced by farmers all over India. They chose crop varieties depending on soil type and depths, water-holding capacity, slope and drainage and by observing their interactions with each other. A variety of agricultural implements were used to ensure efficiency of agricultural operations on one hand while ensuring the conservation of biodiversity on the other. The use of drill plough in sowing operations by Indian farmers has been a classical example of such practices.

The traditional Indian agriculture, thus, generally ensured food security while also preserving genetic diversity. It was as late as around 1800 AD that South Arcot produced

around 33 quintals of paddy per hectare while the more fertile Ramnad district produced as much as 66 quintals/ha. (Cambridge Economic History of India). Similar high level of productivity was reported by Francis Buchanan and others from other parts of the country. As mentioned above the Indian farmers grew a variety of crops including cereals, pulses, millets, fruits, vegetables, oil seeds, fibre crops and spices etc., besides fodders and green manure yielding plants. It is important to note that in each of these cases a large number of varieties and species were grown across the country. Details of some of these are given by Vandana Shiva & Radha Holla Bhor in their Ecological History of food & farming in India. It also provides a glimpse into the biodiversity of livestock and fishes, which are facing serious threat from the onslaught of industrial dairying and fish cultivation.

The practices of Bee-keeping were also followed rigorously to encourage conservation of biodiversity and encourage crop productivity. Similarly, the use of cattle and other animals in various operations of agriculture was primarily to ensure decentralized production system and thereby sustain biodiversity. Thus, a large variety of animals and their local breeds were standardized to optimally utilize their capacities. The use of cattle, horses, mules, camels, yaks and even elephants in forest operations was widely prevalent. The animals were used for a variety of purposes ranging from farm operations to water harvesting and transport etc., besides providing dung to be used as manure in the farm operations or as a source of energy in its dried form.

Unscrupulous use of mechanized farm operations has not only created major problems of destroying employment opportunities in our rural areas but also has been responsible for erosion of biodiversity of the cattle and livestock. The marked decline in the cattle population in the country (as the ratio of human population per 1000) from 430 in 1951 to 278 in 1981 is a matter of concern for all of us. Similarly, there has been marked decline in the population of sheep and goats during the last decades. The loss, particularly in the population of male cattle and that too of some of our best breeds, viz., Shival, Hariyana, Rathi, Ongole, Hallivar or Nagauri is a matter of serious concern for sustainable development and conservation of biodiversity.

Health Care: The health care systems in India used a variety of plants as enlisted in various texts starting from Atharvaveda, Charaka, Sushruta and Vagbhata Samhitas and various Nighantus. The Siddha texts and Unani Compendia also use almost all these plants with a few variations. While about 1500 plant varieties are mentioned to be used by these various organized health care knowledge systems, more than 8,500 types of plants have been recorded to be still in use by tribals and in folklore health care systems.

The role of indigenous institutions has been important in regulating the use of resources as well as folk knowledge by community administration and rituals whereby the judicious exploitation of the plant and other living material was advocated to ensure conservation of biodiversity. While the problem of some important herbs not being available with time (getting extinct) has been reported in various texts from 10th century AD (Vagbhata), their alternatives available in different locations were always mentioned.

While the traditional pharmaceutical technology encouraged the use of bulk quantities of raw drugs, it also encouraged the use of locally available medicinal plants, which ensured that the community followed the rituals to preserve these plants and their biodiversity. It may be important in today's context that some technological modifications may become imperative to obtain large quantities of these health care products for large scale commercial applications.

Food Processing & Nutritional Products: The variety of food products in different parts of the country and their variation according to seasons has been a matter of global attraction. The food processing techniques practiced in different parts of the country and the use of a variety of species, fermentation and preservation techniques have been so prevalent that almost every household of a region specialized in certain food products. The variety of sweets, sour and salty dishes produced in different parts of the country on different occasions also used a variety of locally available cereals, pulses, millets, fruits, vegetables, spices as well animal/non-vegetarian materials. All these ensured the conservation of local biodiversity as these preparations were often linked to various rituals and festivals or religious occasions. The emphasis on the intricate linkage between nutrition and health as well as the question of Pathya (food advised under a particular

health/disease condition) as well as Apathya (food non advised similarly) is another unique concept which has been in practice since the advent of Ayurveda and encouraged people to use a variety of locally available fauna and flora. This ensured the cultivation and/or preservation of all those varieties and hence emphasized on the rich biodiversity preservation measures.

A variety of wild species were also used all over the country as foods and nutritional supplements. Thus, fruits like *Aegle marmelos*, *Madhuca indica*, *Artocarpus heterophyllum* or *Coccoloba* spp. etc., or vegetables viz., *Butea monosperma*, *Amaranthus*, *Asparagus racemosus*, *Chenopodium*, *Dioscoria* or *Centella asiatica* or their grains, oils and wild pulses were all used to ensure that the forests and their biodiversity were preserved. The use of many of these wild species was also particularly helpful in maintaining health of the people.

Textiles and Clothing: The choice of textiles for clothing in the indigenous approach ranged from locally available cotton fabric to jute, leather and silk from a variety of worms. Thus, while the farmers encouraged cultivation of a large variety of locally available cotton crops, the artisans developed technologies to use these for making fabrics of a wide range. Thus, the local cotton crop variants were used as strengths to not only have a variety of textiles but also to conserve the cotton germ-plasm. A variety of spinning wheels and looms were also developed in the process to use the variants of cotton locally available and weave cloth of counts as high as 500 to 600.

Similarly, the silk yarn was developed from a variety of silk worms which could be grown on a range of tree leaves from castor to mulberry or sal etc. all this encouraged conservation of the biodiversity, both of the silk worms as well as plants used to rear them. It was necessary that in all these cases the size of machinery was such that it could allow operations at a level which was economically viable and yet technologically sound to withstand local as well as broader competition.

Even in the field of leather, the Indian practice was largely to use the carcass of dead animals, rather than killing the animals to remove their hide for the leather. Thus the emphasis has always been on conservation of biodiversity rather than destroying the same for the satisfaction of their needs or desires of commercial exploitation

Housing and Habitat: While most of the civilizational development in India also was around the river basins or around coasts, habitations did grow even in the difficult hilly, desert as well as hot and humid forest areas or cold temperate plateaus of Tibet. However, what is important to realize is the fact that the use of processed mud, lime or other local minerals was encouraged to use local material so that undue transportation and destruction at large scale could be avoided. . The development of Madras mortar is a classical case described for more than five centuries to construct even huge structures. A vast variety of grasses, bamboo, coconut and trees for timber in building construction for structures as well as thatches did encourage conservation of biodiversity also through use of organic materials like jaggery and other gums, lacquering agents, and resins in the building industry.

Water: While India is rich in its water resources due to its unique position having access to the monsoons , both from the north and south, as well as the protection from the great Himalayas which would not allow its clouds to go beyond India, the Indian Developmental ethos did not allow the wastage of its water or polluting its water sources. Thus, they not only revered its water bodies but also ensured their conservation through community action and rational utilization. The development and use of pitcher rather than a glass is a classical example. While it is obvious that development and making of a glass would have been much easier for the potters, the social system encouraged them to go in for a more difficult option of developing the pitcher or the Kumbh that would help in conservation of water while using it in a more hygienic manner.

While development of local canal networks or the smaller water bodies localized in an area were encouraged, large scale water bodies were not encouraged lest they destroy the local habitat and disturb the ecosystems. The development of a large number of wells, ponds, lakes, Johads, Bavdis and such other structures has been reported from different parts of the country for millennia to conserve water. Various rituals were devised in the society whereby water bodies were to be cleaned regularly to ensure purity of water.

Energy: While the Indian society evolved a developmental framework whereby the requirement of energy was kept to a minimum, they met their energy needs largely through decentralized energy production systems viz. draught animal power, hydroelectricity through Gharats or mini hydel plants or biofuels for household needs of fuels etc. Most of the industrial needs were met through decentralized production systems utilizing decentralized energy production systems. Such systems ensured that the biodiversity was conserved and the biological resources were not destroyed due to small scale operations.

Transport: The transport was, on one hand restricted to supply of essential materials and on the other use a variety of transport systems, which depended on a range of technologies from animal power to water ways using boats and ships for which India was globally recognized and did conduct trade from far and wide. They had even developed advanced technologies of water proofing of ship bottoms with the Dammer and other plant based products.

Artisanal Products and Technologies: The technologies for production of a wide range of agricultural products, animal foods, dyes, chemicals, handloom and handicraft items as well as those involved in daily use were produced by our artisans. They not only developed a range of agricultural and food processing equipments like rice and pulses pounding machines, oil expellers etc. but also developed technologies for making iron and steel as well as arms and ammunitions. The importance was in developing all these technologies at a decentralized small scale so that they would not cause large scale destruction of natural habitat, resources or biodiversity.

Technological Developments and Biodiversity Conservation

While we had a rich tradition of the technologies for sustainable development, as described above, the development of technology was not only hampered during the colonial rule but actually eroded the technology base of our indigenous and artisanal industries to support industries from the European rulers. Though a chain of S&T

institutions has been set up in the post independence era, most of these institutions have followed the western paradigm of development and hence have continued to work for development of technologies suitable to development of large industries which do not sustain or support biodiversity. Obviously, these technologies also do not support livelihood needs of the vast majority of our people who are living either below or at the margin of poverty line.

Though a few technologies have been developed by some CSIR and ICAR institutions, as well as KVIC, to support decentralized production systems, most of other R&D institutions have not been able to give due attention to development of technologies for supporting and sustaining biodiversity. Some Voluntary Agencies and Non governmental institutions have also started taking interest in some of these areas and have come out with appropriate technologies.

Strategies and Actions Related to Technology

Strategy: The key to generation or selection of Technology for ensuring Conservation of Biodiversity is to

- i) ensure sustainability of the processes
- ii) ensure preferential utilization of locally available and renewable raw materials
- iii) optimize use of materials and energy
- iv) ensure employment generation
- v) ensure that it does not have negative impact on the Environment or the Habitat around it

Actions: Since Technology is also treated as a commodity in today's marketplace, it is developed, promoted and picked up according to the market demands. Since development of Conservation oriented technology is not a priority for most of the large market demands, the R&D institutions of the Industry are not interested in developing or promoting such technologies unless pressurized by the governments or the civil societies. If the Government is to ensure fulfillment of

livelihood needs of its people while ensuring Biodiversity conservation for future generations, it has to ensure development of such technologies.

- i)** Obviously, the priorities of research in public sector institutions and their R&D budgets have to reflect such needs of the society.
- ii)** R&D institutions and Agencies have to change their orientation towards developing such technologies.
- iii)** Appropriate production and market support systems have to be provided to ensure success of such technologies.

It is, therefore, necessary that we must not only identify major rural industries in the sectors mentioned earlier but also ensure the following:

- i)** Evaluate the technology and material needs of such industries in terms of their processes & production technologies, design and other related parameters to serve the cause of BD conservation.
- ii)** Based on the available data on the status of such technology, relevant R&D and S&T institutions and agencies have to be identified for engaging them in the process of technology development with the right perspective.
- iii)** Identify relevant management and marketing institutions which may be involved for providing the appropriate market support systems and strategies.
- iv)** Evolve appropriate legal and regulatory framework for ensuring their implementation.