BIO-DIVERSITY : CONSERVATION AND MANAGEMENT

H. N. GOUR
Professor & Head
Department of Plant Pathology, Maharana Pratap University of Agriculture & Technology, Udaipur, 313 001, India

It indeed is a welcome and very timely step by the premier scientific front runner organization - the Maharashtra Academy of Sciences to organise a workshop on the today's burning issues of global warming, Ecological imbalances, aiming at Conservation and Management of biodiversity. The bio-diversity has been well defined by Al Gore as "you look at that river gently flowing by. You notice the leaves rustling with the wind. You hear the birds' you hear the tree frogs. In the distance you hear a cow. You feel the grass. The mud gives a little bit on the river bank. It is quiet; it's peaceful. And all of a sudden, it's a gear shift inside you. And it's like taking a deep breath and going….. Oh' yeah, I forgot about this" (An inconvenient Truth). The former Vice-President of the United States had to reinvent himself to become nature's oracle. The rate of consumption of the earth's resources by the human race is posing a threat to the sustainability of life on the planet earth. Nevertheless, the global energy industry, along with its patrons and affiliates, has finally come around to accepting this verdict. However, the efforts of the scientists might not have made the world wakeup to the perils of global warming if a protagonist with a powerful voice had not stepped forward to convey the message. One may be reminded of the words uttered by the great leader of the Native American Squeamish Tribe, chief Seattle, who was a scholar with love for his land and people. The great leader said about a century and half ago, "Teach your children what we have taught ours, that the earth is our mother, whatever, befalls the earth befalls the sons of the earth. The earth does not belong to man; man belongs to the earth. Man did not weave the web of life, he is merely a strand in it. We do not inherit the earth from our ancestors; we borrow it from our children". These words spoken by Chief Seattle are more pertinent and most relevant in today's context of human activities on earth.

The five years (December 27, 1831 – October 2, 1836) Charles Darwin, the English naturalist spent on board HMS Beagle in a round the world voyage gave him the opportunity to study and compare the fauna, flora, and geology of many distant lands. It led him to wonder about the diversity of life forms he found and why creatures occupying similar environments in places around the globe could be so vastly different. The idea that biological species were not immutable but were capable of change was in itself not new at the time. Darwin would have been familiar with the speculations of his own grandfather, Erasmus Darwin and the French Zoologist, Jean – Baptiste Lamarck. But within a couple of years following the Beagle Voyage, Darwin was going much further. He was thinking about a common origin for all life on the planet when he sketched in his note book a tree of life, implying that all species had diversified from a common stalk.

However, Darwin was not the only one thinking along such lines. In 1858, he received a letter suggesting ideas remarkably like his own; it was from Alfred Russell Wallace, who was collecting biological specimens in south-east Asia.

Papers putting forth both points of view were duly presented at a meeting of the Linnean Society of London. The origin of species (As Darwin's 1859 magnum opus came to be titled in 1872, in the sixth edition) marshalled a vast body of evidence and presented his arguments in favour of evolution driven by a process of natural selection that allowed traits best suited to a particular environment to spread in a population. Evolution and a common origin for all life lie at the heart of biology. In an essay strikingly titled 'Nothing in biology makes sense except in the light of evolution', the geneticist and evolutionary biologist Theodosius Dobzhansky declared, "Without that light (Biology) becomes a pile of sundry facts – some of them interesting or curious but making no meaningful picture as a whole". The elucidation of the structure of DNA, the unravelling of genetic code, and the ability to sequence the entire genome of even complex organisms have served only to lay bare the processes that produce life, which all living organisms share, and show how evolutionary pressures act on those processes. As though this were not enough, Darwin's ideas have inspired, over the past century and a half. "Powerful images and insights in science, humanities and arts", as an essay in Nature reminds us.

In fact, what Darwin would have deciphered about the facts of biologicals, could have been traced in the ancient epic scriptures where it has been stated that all the worldly manifestations have single divine origin. Religiously may be but scientifically more we can have an analogy of DNA-the blue print of life, which all organisms share uniformly and diversity exists in each and every living object of the world because of laddered language of nucleotides in different modes every time. We are required, therefore, to respect and value the ecological system. In His prophetic teachings Lord Krishna says that "I am the cause of whole world, I am there in fish, in vegetation, in animals and all human beings. All worldly affairs are regulated by me and thus the cycle of universe goes on". Consequently, the richness of biodiversity is a manifestation of divinity or DNA (As science would endorse). Whether it is divinity or DNA (Divine Nucleic Acid) the origin of all species in ecology is from a single strand/source. What an amazing spectacle of nature? Biodiversity encompasses the variety of all life on earth. India is identified as one of the 12 mega biodiversity rich countries. With only 2.5% of the land area, India already accounts for 7.8% of the global recorded species. India is also rich in traditional and indigenous knowledge, both coded and formal.

The biodiversity of earth is astounding. Our planet supports between 3 and 30 million species of plants, animals, fungi, protozoa, Nematodes, bacteria, viruses, etc. Despite 2 centuries of research, systematicists have described only about 1.4 million species. The ecology or role of these species in ecosystems, has been studied for less than one per cent. We know more about large, economically important plants and animals than we do about fungi and bacteria, despite their important ecological roles. There are plants of great variability possessing several different types of chemical constitutions, biochemical process and genetic variabilities such as tallest tree which is called as stratosphere Giant, grows in the Rockefeller Forest, Humboldt Redwoods state Park, California, is 112. 32m. The General Sherman giant sequoia in sequoia National Park, California, USA, is the world's largest living thing. It is 83.3m tall and measures 2.53m round its mighty trunk. It weighs about 2000 tonnes including its huge root system. On the contrary, Wolffia, a kind of duckweed, is just 0.6 mm long and weighs about as much as two grains of salt. Its seeds are the tiniest known- they weigh only 70 micrograms, as much as a single grain of salt. It is the smallest flowering plant known on the earth.

There are carnivorous plants too, plants that can grow luxuriously on marshy lands as well and thus we can see a large diversity of species in plant kingdom documented thus far.

Interestingly enough the researchers examining plants growing in the geothermal soils of Yellowstone National Park and Lassen Volcanic National Park have found evidence of symbiosis between fungi and plants that may hold clues to how plants adapt to and tolerate extreme environments. This research was published in the journal Science.

Biologists Regina Redman of the University of Washington and Joan Henson of Montana State University and their colleagues examined 200 samples of Dichanthelium lanuginosum, also called "Geyser's Dichanthelium," for fungal colonisation. They found what may be a new species of the fungus Curvularia that survives only in temperatures greater than 98 degrees when it associates with plants. The researchers suggest that thermotolerance may occur through symbiotic mechanisms like heat dissipation by pigment, such as melanin, or activation of a 'biological trigger' that tells the plant to react to temperature changes or strongly than plants that lack the fungus.

Haksworth (1991) estimated that on a world wide basis there are about 1.5 million species of fungi. To date, however, only about 80,000 species have been described. There is a tremendous discrepancy between the numbers of known versus estimated species appears to relate to the fact that there has been woefully inadequate sampling of fungi in many parts of the world, most notably tropical and subtropical regions. Currently there is a lots of interest in and actually a sense of urgency about documenting the world's fungi. This is coming about at the same time that we are beginning to see reports concerning alarming decreases in both the total number of fungal species and the quantity of individual species in Europe. In the case of tropical and subtropical regions it would indeed be a tragedy to lose species to extinction before we even have determined that they exist. This is, however, more than just a philosophical or ethical concern. Fungi are extremely valuable sources of chemicals, including various antibiotics, and also have great potential as biological controls for many serious pests. As noted by Hawksworth (1991), "the world's undescribed fungi can be viewed as a massive potential resource which awaits realization.

The role that mushrooms play in the religion and mythology of endemic Mexican and Guatemalan peoples is well documented and the use of the hallucinogenic mushroom Psilocybe cubensis in the religious rites in some parts of Mexico has been interestingly described by various authors.

The reproductive structures produced by some species and, in some cases, wood permeated by hyphae actually may give off visible light causing them to glow in the dark. This phosphorescent glow has long fascinated and even frightened humans, and much has been written about the subject. Observations on bioluminescent fungi can be traced as far back as Aristotle times. Apparently, people have long used pieces of bioluminescent wood to mark their paths at night, and there even are reports of soldiers attaching pieces of luminous rotten wood to their helmets in order to be visible to one another at night. In the United States the glow produced by bioluminescent fungi has been referred to as foxfire.

One of the better known species is the so-called Jack-0- Lantern mushroom, whose orange gills glow in the dark. Unfortunately for the discipline of mycology, few individuals realize how intimately our lives are linked with those of fungi. However, it truly can be said that scarcely a day passes during which all of

us are not benefited or harmed directly or indirectly by these inhabitants of the microcosm. For example, if you are much under the age of 50, it is probably difficult for you to comprehend how many lives have been saved by penicillin.

It is possible that you too may have survived to study fungi because of a fungal antibiotic. It is obvious that individuals who study fungi must do a better job of educating the general public about the importance of these organisms. The example of a recent event that probably has done more along these lines than anything else in many years was the report that Armillaria bulbosa, a fungal species that is a facultative parasite of tree roots, may be among the largest and oldest living organisms. This report not only was highlighted in the scientific press but also was reported widely in newspapers in North America and Great Britain. Basically, what scientists reported was that one clone of Armillaria bulbosa—dubbed "fungus humongous" by the popular press—occupies a minimum of 30 acres in a Michigan forest and that the thallus or body of the organism weighs in excess of 10 tons/ The age of this thallus was estimated to be more than 1500 years.

Insects can affect sexual reproduction in some plant pathogens, such as the rust fungi, by carrying spermatic (gametes) between different mating types. This function of insects is analogous to their role as pollinators of plants, and contrasts with their more widely known role as vectors of plant pathogens' infectious spores. There is a report of an extraordinary case of pathogen-mediated floral mimicry that contributes to fungal reproduction. The rust fungus Puccinia monoica inhibits flowering in its host plants (Arahis species) and radically transforms host morphology, creating elevated clusters of infected leaves that mimic true flowers of unrelated species in shape, size, colour and nectar production. These fungal pseudo flowers attract insects which fertilize the rust. Because the pseudo flowers are highly successful in attracting pollinating insects.

Bioresources are important components for progress and economic activities of a nation. But bio-resources management and utilization for human welfare is very important for the optimum utilization of the bio-resources. Awareness of the importance and implications of bio-resources among common

people as well as elite educated citizens for safeguarding and protecting the optimum and balance way of using the bio-resources needs critical studies to focus the natural bio-resources wealth for the benefit of not only the present generation of our people but also to our future generations for their better, healthy and peaceful living on the earth. The problems facing at present is the over exploitation of bio-resources which would not only have negative impact on the environment but also sometimes totally destroy and erode the important bio-resources which are available at local level, regional level and national levels. Biological resources includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity. Therefore, handling Bio-resources in a proper manner in an appropriate way is important for the optimum use without over exploitation of our bio-resources wealth.

Biodiversity is being lost as on today more rapidly than at any time in the past several million years. Some Biologist believe that about 60.000 of the world's 2,40,000 plant species perhaps even higher proportions of vertebrate and insect species could have become extinct within the next thirty years if the same trends continue. But even a species at no risk of extinction can lose much of its potential through the loss of genetic material by reduction in range, numbers and varieties.

The current losses to biodiversity can be attributed to direct causes including habitat loss and fragmentation, invasion of introduced species, over exploitation of living resources and modern agriculture and forestry practices. The basic problems of losses to biodiversity includes :

- The unsustainably high rate of human population growth and natural resources consumption.
- The Steadily narrowing selection of traded products from agriculture, forestry and fisheries.
- Economic systems that fail to value economic resources.
- Inequity in ownership, management and flow of benefits; from both the use and conservation of Biodiversity.
- Deficiencies in knowledge and application
- Legal and institutional systems that promote unsustainable exploitation.

Loss of species and genetic diversity presents a serious threat to the goal of sustainable agriculture. Species and genetic diversity provide sources of pest resistance and control, new domesticates and the genetic raw material for plant breeding and genetic engineering.

After an extensive and intensive consultation process involving the stakeholders, Central Government has brought Biological Diversity Act, 2002, with the following features.:

- To regulate access to biological resources of the country with the purpose of securing equitable share in benefits arising out of the use of biological resource and associated traditional knowledge relating to biological resources.
- To conserve and sustainable use of Biodiversity and Biological resources.
- To respect and protect traditional knowledge of local communities relating Biodiversity.
- To secure sharing of benefits with local people as conservers of bio-resources and holder of knowledge and information relating to the use of bio-resources.
- Conservation and development of areas of importance from the status of biological diversity by declaring them as biological diversity heritage site protection and rehabilitation of threatened species.
- Involvement of Institutions and State Governments in the broad scheme of the implementation of the Biological Diversity Act through constitution of State Biodiversity Boards (SBB) and Biodiversity Management Committees (BMC).

It is very important to protect and conserve the Biodiversity for the welfare of the human beings and awareness on the importance of Biodiversity and its economic values as well as threats to biodiversity among the common people, elite citizens, teachers, scientists, administrators, scholars, students and school children needs to be created to save our National wealth of Biodiversity.

The agricultural biotechnology sector has recently demonstrated a major expansion n India. For example, there has been a 55 per cent increase in the number of agricultural biotech firms from 2001 to 2003. The 132 firms concerned deal with biofertilisers, biopesticides and tissue culture in the main, with relatively few (20) involved in GM crops.' The first approval for the commercial production of any GM crop in India occurred in March 2002 when the Indian competent authority approved three varieties of GM cotton (MECH 12, MECH 162 & MECH 184 expressing the cry]Ac gene) amid widespread protests by anti-GM activists.' This

was followed by a significant increase in the availability of approved Bacillus thuringiensis (Bt) cotton (currently 135 hybrid varieties; better suited to Indian cultivation.

The goal of the Indian regulatory system is to ensure that approved GM crops pose no major risk to food safety, environmental safety or agricultural production.' As such, the Government of India has adopted a policy of careful assessment of the benefits and risks of GMOs at various stages of their development and field release to ensure biosafety.'

The existing regulatory framework takes the form of rules and guidelines and is based upon three specific provisions (viz. Sections 6, 8, and 25) of the Environment (Protection) Act of 1986 (EPA). While Section 6 of the Act empowers the Central Government to make rules on procedures, safeguards, prohibition and restrictions for handling of hazardous substances. Section 8 of the Act prohibits a person from handling hazardous substances, except in accordance with procedures and after complying with safeguards. Section 25 of the EPA empowers the Central Government to lay down rules regarding procedures and safeguards for handling hazardous substances. These provisions of the EPA led to the adoption of the 1989 Rules for the Manufacture, Use, Import, Export and Storage of hazardous Microorganisms, Genetically Engineered Organisms or Cells (1989) rules which are statutory in nature.

In 1994 the Government of India revised its earlier guidelines of 1990, entitled "Revised Guidelines for Safety in Biotechnology". These revised guidelines aimed at regulating shipment and importation of GMOs for, laboratory research, as well as large-scale production and the deliberate release of GMOs, plants, animals and products into the environment. By 2002, an array of legislation had come into existence. This included the National Biodiversity Act, 2002 (NBA), and the Protection of Plant Varieties and Farmers' Rights Act, 2001 (PPVFR), the latter of which derived from a broad-based consultation with a view to incorporate a form of farmers' rights into the national plant variety rights legislation. The biosafety rules have since been supplemented by the Biotechnology Safety Guidelines. These Biotechnology Safety Guidelines have been issued in pursuance of Rule 4(2) of the Biosafety Rules(1989), which require manuals of guidelines to be brought out by the Review Committee on Genetic Manipulation (RCGM).

Therefore, the Indian biosafety regulatory framework, comprising the 1989 Rules and the guidelines issues under this in 1990, 1994 and 1998 DBT guidelines, covers the entire spectrum of activities relating to GMOs. This includes "research involving GMOs, as well as genetic transformations of green plants, recombinant DNA (rDNA) technology in vaccine development, and large-scale production and deliberate/accidental release into the environment of organisms, plants, animals and products derived from rDNA technology'. Production facilities such as distilleries and tanneries that use GMOs are also covered. In India, the risk assessment and regulatory approval for releases of GMOs and GM products are mandatory. The concept of 'biosafety' used in the regulations is a broad one, covering the health safety of humans and livestock, environmental safety (ecology and biodiversity) and economic impact.

Two nodal agencies, the Ministry of Environment and Forests (MoEF) and the Department of Biotechnology (DBT) under the -Minisrry of Science and Technology are responsible for the implementation of the regulations. The life-cycle of a GM product features four domains, pre-research, research, release and post-release, and the approval mechanism involving six competent authorities.

The Recombinant DNA Advisory Committee (RDAC) is in the pre-research domain as it triggers research through its initial approval mechanisms. The Review Committee on Genetic Manipulation (RCGM) resides in the DBT and functions in the research domain, closely monitoring the process of research and experimental releases. It requests food biosafety, environmental impact and agronomic data from applicants who wish to do research or conduct field trials and will give permits to import GM material for research. Pursuant to Rule 4(2) of the "1989 Rules", the RCGM is also required to produce manuals of guidelines.

The RCGM is primarily made up of scientists from various disciplines and can request experts with specialized knowledge to review cases. It has a Monitoring cum Evaluation Committee (MEC) that monitors limited and large-scale field trials of GM crops and is primarily made up of agricultural scientists. Commercial production of GM crops, large-scale field trials of GM crops, and the imports of GM commercial products and GM-derived products (for example foodstuffs, ingredients in foodstuffs, and additives including processing aids containing or consisting of GMOs) come under the authority of the Genetic Engineering Approval Committee (GEAC) at the MoEF. The committee members are scientific experts and bureaucrats representing different ministries and, like the RCGM, can request assistance from experts with specialised knowledge. Additional to these national committees are the State Biotechnology Coordination Committee (SBCC) and the District Level Biotechnology Committee DLC), who, along with the MEC, basically occupy the post-release domain, although they also contribute to the research domain activities through data-provisioning to the RCGM. Completing the regulatory apparatus are the Institutional Biosafety Committees (IBSC) which undertake the monitoring and implementation of safeguards at the R&D sites, under the close supervision of the RCGM, the SBCC and the DLC. IBSCs must be established in any public or private institute using rDNA in their research and comprise scientists from their respective institutes and at least one member nominated by the DBT. There are more than 230 IBScs in India, of which 70 deal with agricultural biotechnology. They can approve contained research at institutes unless the research uses a particularly hazardous gene or technique which will require specific approval from the RCGM. All the IBSC approved projects are sent to RCGM for further approvals. In general, these authorities are vested with non-overlapping responsibilities.

Genetically modified plants that can break down pollutants may be an effective way to clean soil contaminated by industrial chemicals and explosives used by the military, say scientists.

Tests on six-inch tall GM poplar cuttings which had a gene from a rabbit inserted into them showed that they could remove up to 91 per cent of a chemical called trichloroethylene from the water used in their feed. This chemical, used as an industrial degreaser and one of the most common contaminants of ground water, was broken down by the plants into harmless by products more than 100 times faster than by unaltered plants.

“In view of their large size and extensive root systems, these transgenic poplars may provide the means to effectively clean sites contaminated with a variety of pollutants at much faster, rates and at Power costs than can be achieved with current conventional techniques”, Sharon Doty, of the University of Washington, Seattle, on Monday in the Proceedings of the National Academy of Sciences (PNAS).

The GM poplars also broke down other common environmental pollutants such as chloroform, a byproduct of the disinfection of drinking water, the solvent carbon tetrachloride, and vinyl chloride, used to make plastics. Poplars use an enzyme called cytochrome P450 to break down contaminants. Trichloroethylene is turned into a harmless salt, water and carbon dioxide.

Another study, also published in the PNAS, demonstrated a way to break down the military explosive RDX. 'Widespread contamination of land and ground water has resulted from the use, manufacture, and storage of the military explosive RDX. This contamination has led to a requirement for a sustainable, low-cost method to remediate this problem," wrote Neil Bruce, of the University of York. "One of the biggest concerns of RDX as a pollutant is that it migrates readily through soil into the ground water and subsequently contaminates drinking water supplies". His team genetically modified Arabidopsis plants to express enzymes called XplA and XpIB, which are known to break down RDX. At their best, the plants reduced RDX concentrations from soil by up to 97 per cent in one week.

Though the GM plants may be an effective way to treat pollutants, Dr. Doty acknowledged that people might have concerns at the thought of forests of GM trees. In the United States and Britain, such plants can currently only be grown for research purposes. Dr. Doty added that poplars were fast-growing and could grow for several years without flowering, so there was reduced risk of their genes being transferred into wild populations of the tree.

Conservation : The science of protecting and restoring biodiversity and ecological health. The basic principles of which include ecology, evolutionary biology, genetics, physiology all applied to achieve the goals of maintaining and managing biological diversity as well as ecological health.

It is heartening to note that the world’s largest population of Irrawady has been found recently in Bangaldesh’s waters according to a five year wildlife study. Until now, it was believed that the small light-grey mammal, famed as an aquarium attraction, was threatened and the International Union of Conservation of Nature had put five of its South-East Asian populations on its list of critically endangered animals.

These require society at large, legislatures and governments to be involved and to pay special heed. Sadly, while the governments of about 190 nations have signed to honour the Declaration, many of them do not seem to look around us. The U.S. government wants to deface Alaska by digging for oil there, and also refuses to believe in global warming. Japan, Russia and some Scandinavian countries want the ban on whale-hunting lifted, knowing fully well that the ban has been imposed to save the majestic marine mammal from extinction. Then we learn about the steady depletion of the tropical rain forests of the Amazon. As the song laments: "When will they ever learn?"

Government dithering

Look closer to home. The government is pushing ahead with the Sethusamudram Project, even as environmentalists and several scientists warn us of the loss of precious coral reefs and associated marine life forms.

Soon after the asbestos-laden ship Clemenceau is turned away from the Alang Shipwrecking yards, thanks to environmentalists' pressure, another of its kind is permitted in.

The river Ganga, held sacred by millions, is polluted day in and day out by domestic and industrial wastes. Yet the government dithers about the modes of implementing its own Ganges Action Plan (started almost fifteen years ago).

The government's intentions are honourable, the money has been set apart and yet the follow-through is taking years. The sanctity of the river, in the meanwhile, continues to be debased. One Chief Minister wanted to deface the ambience around the glorious Taj Mahal with bricks and cement, to build a shopping mall, before the courts stopped it.

Are these acts ethical? Are these what we want to leave behind for our children?

Sadly, while just about every political leader and government around the world professes commitment to guard the environment and concern for the future generations, most of them have not lived up to their promise.

In this regard, what the Israeli Parliament (the Knesset) has attempted to do is admirable and worthy of a similar action by India (and indeed many other nations). Called the Israeli Commission for Future Generations, it was created by law as an inner parliamentary entity. Its role is to overview each legislative process, with special regard to long-term issues, and to attempt to prevent potentially damaging legislation from passing the Knesset. This commission is given the authority to initiate bills that advance the interests of the future generations.

It is also entitled to provide the parliament with recommendations, and the opinions and recommendations of this commission have to carry a scientific character, be detailed and include comparative research.

In fact, the financial crisis for which we must now pay so heavily prefigures the real collapse, when humanity bumps against its ecological limits. On Friday (October, 10). Pavan Sukhdev, the Deutsche Bank economist leading a European study on ecosystems, reported that we are losing natural capital worth between $ 2 trillion to $ 5 trillion as a result of deforestation alone. Whereas, the losses incurred so far by the financial sector amount to between $1 trillion and $1.5 trillion. Sukhdev arrived at his figure by estimating the value of the services - such as locking up carbon and providing fresh water - that forests perform, and calculating the cost of either replacing them or living without them. The credit crunch is petty when compared to the nature crunch.

The two crises have the same cause. In both cases, those who exploit the resource have demanded impossible rates of return and invoked debts that can never be repaid.

Ecology and economy are both derived from the Greek word oikos - a house or dwelling. Our survival depends on the rational management of this home: the space in which life can be sustained. The rules are the same in both cases. If you extract resources at a rate beyond the level of replenishment, your stock will collapse. These are the points to ponder.