SUSTAINABLE ECOSYSTEM: FORGING A NEW HUMAN – PLANT RELATIONSHIP

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Introduction

It is impossible to imagine a life in isolation on this planet. Different forms of lives are associated with flora, fauna and atmosphere around them in the ecosystem. Being the producer, plants play a key role in the ecosystem.

One of the most interesting features of life on this planet is its extraordinary diversity. We share planet Earth with countless other species who provide us essential goods for life including food, drugs, industrial products, genetic resources and much more.

Earlier we were dependent on forests for all our needs. However, over time agriculture and industries emerged as new means to fulfil our desired needs. A harmonious balance among different biotic and abiotic components of an ecosystem is highly essential. However, over industrialisation and growth of the human population as well as the increased requirements of food and other essentials have stressed the natural system. It has given rise to the pollution of air, water and soil and degraded many habitats which has threatened the survival of many species.

The plants check air pollution by reducing the amount of carbon dioxide in the air and supplying oxygen through photosynthesis. Plants help cleaning up of synthetic chemicals and bacteria from water and soil as well as help in minimising undesirable noise pollutions. They prevent soil erosion, filter dust and cool atmosphere in neighbour hoods.

For wildlife, the plants can be their food source as well as their home. In fact plants play a crucial role in almost all the aspects of life. They support us as good friends through thick and thin. Majority of the environmental issues created due to unbalanced growth can also be solved with the help of technologies, treaties and trees.

Ecosystem

Numberless species and their environment mutually interact to form an ecosystem. Ecosystem is a functional unit comprising abiotic and biotic components. The study of the relationships of living organisms with their environmental abiotic and biotic (other species) components is called ecology. It is mainly the study of organisms, populations, communities and biomes. Light, temperature, water and soil are abiotic factors to which the organisms are adapted in different ways.

The populations of different species in a habitat interact mutually in different ways like

competition (both species suffer), predation and parasitism (one benefits and the other suffers) and mutualism (both species benefit).

The sun powers all the ecosystems on the earth. The energy flow from the sun to producers and subsequently to consumers is unidirectional. The plants are called producers as they produce food from solar energy and provides to all other organisms. The other organisms that consume producers are called consumers. The consumers can be called primary consumers or secondary consumers depending on their sequence in the chain.

The food chains unite to form a bigger food web. The chain or web shows interdependency of organisms. According to the source of their food, organisms occupy a specific place in the food chain that is called trophic level. Producers belong to the first trophic level and herbivores to the second trophic level and so on. However, only 10 per cent energy is transferred to the next trophic level.

Biodiversity

Our living world is amazingly diverse. Since the history of origin of the life on earth goes back to approximately 3.8 billion years, it has given ample opportunity to the life forms to diversify. This diversification is known as biodiversity. It comprises all the diversity that exists at different levels of biological organisation—macromolecules, cells, tissues, organs, organisms, population, communities, ecosystems and biomes.

Biodiversity gives strength to the life. Biodiversity at the level of genes, species and ecosystems of a region are more significant. The variation of genes in a given species is known as genetic diversity .It gives the population an ability to adapt to the environment and to respond to the forces of natural selection. The species diversity is a measure of the variety of species within a region (number of species per unit area). Ecosystem diversity refers to the number of niches, tropic levels and different ecological processes that sustain the flow of energy, food webs and nutrients cycles.

Some 1.5 million species have been identified and recorded on the planet, however, more than 6 million species are yet to be identified and named. Since the tropics provide most ideal conditions for life to grow, the highest species diversity is found in the tropics which decreases towards the poles. India figures among the 12 countries with mega diversity in the world. The communities with higher diversity are more stable, productive and resistant to biological invasions. Biodiversity is essential for maintenance of ecosystem and their sustainable utilisation. Some of the benefits of biodiversity are given in Table 1.

Table 1
Benefits of Biodiversity

Ecosystem services	Prevention and mitigation	Food security	Medicine
(a) Biodiversity maintains gaseous composition of the atmosphere.	(a) Forests and grassland protect landscapes against erosion, nutrient loss, and landslides.	(a) Biodiversity provides the vast majority of our foodstuff.	(a) Biodiversity is a rich source of substances with therapeutic properties.
(b) Controls climate by forest and oceanic systems.	(b) Ecosystems bordering flooding river reduce the damage caused by floods.	(b) The uniqness of wild biodiversity guards against the failure of agricultural.	(b) It has aesthetic value and cultural significance like ecotourism, bird watching, wildlife, and gardening.
(c) Supports pollination of plants.		(c) Source of new crops and bio-pesticides.	
(d) Soil formation and protection.			
(e) Balancing biogeochemical cycles.			

However, this biological diversity of the planet Earth is on decline due to human activities. It is believed that the earth has already witnessed five episodes of mass extinction of species in the past. Today, nearly 15,500 species worldwide are facing the risk of extinction and with this trend within 100 years the number of the species might be reduced to half.

There are four major causes behind extinction of species – habitat loss, over exploitation, invasion of alien species and co-extinction. The rain forest cover has reduced from 14 per cent of the earth's land surface to its half. Overexploitation by humans is the major reason of species extinction in the recent history of life.

Humans obtain numerous benefits from the nature ranging from food, firewood to medicines and other industrial products. Besides, every species has its unique significance and role. Thus, the nations having rich biodiversity can reap its benefits. Besides, it is a moral responsibility to protect and pass on the biological legacy to the next generations.

The World Conservation Union has attempted to categorise the species according to their risk profile into eight red list categories: extinct, extinct in the wild, critically endangered, endangered, vulnerable, lower risk, data deficient, and not evaluated.

Biodiversity conservation has gained importance over time. The conservation strategy may be *in situ* or *ex situ*. In the earlier type of conservation, the endangered species are protected in their natural habitat with a view to protect entire ecosystem. Worldwide, 34 'biodiversity hotspots' have been identified for intensive conservation. The zoos, the gene bank, and germ plasm are examples of *ex situ* conservation.

Forests : The Provider

Forests provide homes to about 300 million people and livelihoods to about 1.6 billion people around the world. Hunter-gatherer, farming, timber, industrial products, etc. are some of the livelihoods associated with forests. Trade in forest products was estimated at $327 billion in 2004.Tropical forests provide a large number of medicinal plants worth about $108 billion a year.

For the rural poor, the forest meets their basic subsistence needs for food, fuel, water and medicine. Growing population is a risk to the healthy forest. However, when forest is managed sustainably it can help in developing forest-based enterprises and services and alleviate poverty of the forest dwellers. Traditional forest related knowledge preserved in the indigenous cultures over centuries is true wealth.

India is endowed with a diverse range of forests. It varies from the forests of Kerala in the South to the alpine pastures of Ladakh, from the desert of Rajasthan in the west to the evergreen forests in the North East. India follows a policy of keeping one-third of the country's total land area under forest and tree cover. These forests sustain a wide range of plant and animal species.

Agronomy: Making Most of Plants Production

With evolution, the agriculture replaced forests as main source of food supplies. The science and technology of producing and using plants is called Agronomy. With the application of agronomic knowledge of irrigation and drainage, crop rotation, plant breeding, soil management, weed and pest control, the production of plants have significantly improved. Biotechnology has helped in promoting and expediting the development of desired traits in plants. It has ensured better food security.

However, water crisis, land degradation, climate change, and different agricultural diseases are posing a threat to achieving food security. Modern technologies have helped increase the food security. Beginning in the late 1960s, the Green Revolution offered much needed solutions to increase the food security. It refers to new researches and development of technologies that increased agricultural production. Application of high-yielding varieties (HYV) of crops, expansion of irrigation facilities, use of new technologies, fertilizers, and pesticides have multiplied the outcomes. As an impact of green revolution, the rice yields in India grew three times to six tons per hectare by the mid 1990s.

Interestingly, the genome of the crops are being altered favourably to address various challenges including water crisis, land degradation and climate change. The crops can be enriched with nutritional values and disease resistance power. Genetically modified foods and fibers are slowly gaining acceptace.

Medicines from Plants

Plants have been depended upon throughout the human history for various cures. Through evolution plants have acquired the ability to produce many compounds to perform various biological functions, including defense against insects, fungi and herbivores. The medicinal properties are basically determined by the secondary metabolites. These are compounds that are not required for normal growth and development but synthesised in specialised cells at particular developmental stages in select medicinal plant species.

A large number of such compounds have been isolated so far. About 25 per cent of the medicines in the global market are sourced from plants. It is assumed that some 25,000 species of plants are used in traditional medicines worldwide which is used by native peoples. It is not known as to how many such medicinal plants are hidden in the forests. Apart from forests, medicinal plants are cultivated on commercial basis to meet the increased demands. Some well known common medicines derived from the plants are listed in Table 2.

The drugs like inulin, quinine, morphine, codeine and digoxin are obtained from the plants. A number of glyco proteins present in Aloevera gel have been reported to have antitumor and antiulcer effects and positive proliferation effect on human dermal cells. The saponins are used in preparation of cosmetics as it tightens the connective tissues.

Table 2
Medicines from Plants

Medicine	Action/Clinical Use	Plant Source
Atropine	Anticholinergic	Atropa belladonna
Codeine	Analgesic, antitussive	Papaversomniferum
Colchicine	Antitumor agent, anti-gout	Colchicum autumnale
Digitoxin	Cardiotonic	Digitalis purpurea
Digoxin	Cardiotonic - used for treatment of atrial fibrillation and heart failure.	Digitalis purpurea
Papain	Proteolytic, mucolytic	Carica papaya
Quinidine	Antiarrhythmic	Cinchona ledgeriana
Quinine	Antimalarial, antipyretic	Cinchona ledgeriana
Salicin	Analgesic	Salix alba
Taxol	First drug of choice in several tumorous cancers including breast cancer.	Pacific Yew tree (Taxusbrevifolia)
Vinblastine	Antitumor, antileukemic agent. The first drug of choice in many forms of leukemia.	Catharanthusroseus (Madagascar Periwinkle)
Vincristine	Antitumor, Antileukemic agent.	Catharanthusroseus

Pollution— a New Age Threat

Pollution has emerged as a new age threat to plants and animals. It is basically an undesirable byproduct of unplanned growth of industry, agriculture and human population. Pollution affects human life, plant productivity besides degrading the ecosystems and modifying climatic patterns. The climate change results in the loss of biodiversity and resilience of all ecosystems, and reduces the productivity of the whole ecosystem (Grimm, et al., 2013). It influences the life cycle of animals, such as migration, blooming, and mating. It also destroys habitats, food webs and increases the risk of extinction of species.

As per the report of World Health Organisation (WHO), around 80 per cent of the urban population are facing poor air quality. The air pollution has been classified as a carcinogenic to humans. The impact of air pollution is huge in terms of health. Outdoor pollution alone is responsible for 1.3 million premature deaths yearly (WHO, 2013).

One of the simplest ways to reduce the effects of pollution is to increase green cover on the planet. The plants provide safe and sustainable solutions to some of the biggest environmental problems.

Phytoremediation — Plant-based Technology

Phytoremediation is a new method for cleaning up pollution and wastes with the help of plants. It is gaining popularity in the waste management field because of its eco-compatibility.

Phytoremediation process enhances the plant's natural uptake capabilities using different strategies.Phytoremediation is used for remediating polluted water, soil and air. In phytoextraction, such hyperaccumulators plants are used which can absorb metallic pollutants from the contaminated sites through the roots and translocate them to the shoots. In Phytostabilisation, those plants are used in which their roots interacts with microbes to immobilise organic and inorganic contaminants by binding them to soil particles and consequently check contaminants from mixing with ground water. In Phytofiltration plant roots absorb or adsorb pollutants from water and aqueous waste streams (Prasad and Freltas, 2003).

Recently scientists have successfully incorporated two genes from bacteria which can consume RDX in two grass species namely switchgrass (Panicumvirgatum) and creeping bentgrass (Agrostisstolonifera). The grasses are capable of removing all the RDX from the soil without retaining any toxic chemical in their leaves or stems. The RDX is a military explosive and a man made pollutant. It causes seizures and organ damage and is known as a potential human carcinogen. The plants could be the only affordable and sustainable solution to cleaning up RDX from polluted sites on world wide scale. Thus, using genetic engineering, the plants can be taught to over express certain genes for phytoremediation.

Role of Treaties and Technologies

The effect of pollution, loss of biodiversity and climate change is felt across the political and geographical boundaries. The management of the same requires an integrated global response. The nations across the globe sign environmental treaties or agreements to find a collective solution for the safety of the

planet and humanity. It has emerged that the principles of common but differentiated responsibilities may help the nations unite towards a common cause.

In 1972, Stockholm, Sweden, hosted the first United Nations Conference on Human Environment. The conference introduced for the first time the idea of relationship between development and environment.

Depletion of ozone layer in stratosphere enveloping the earth was a serious risk some time back. However, as a result of the Montreal Agreement (1987), the production and use of the most of the harmful Ozone Depleting Substances (ODSs) have been phased out globally. For this reason this agreement is known as one of the most successful environmental treaties which mobilised the member states to act in the interests of human safety to protect from severe ozone depletion and an impending hazard (Velders, et al., 2007).

International treaties like Rio Earth Summit (1992), Kyoto Protocol (1997) and Paris Agreement (2015) are major initiatives in this direction. The Convention on Biological Diversity (CBD) or Biodiversity Convention, a multilateral treaty was opened for signature at Rio in 1992 and entered into force in 1993. It aims at biodiversity conservation, its sustainable use, and fair sharing of genetic resources. It has two supplementary agreements as shown in Fig 1.

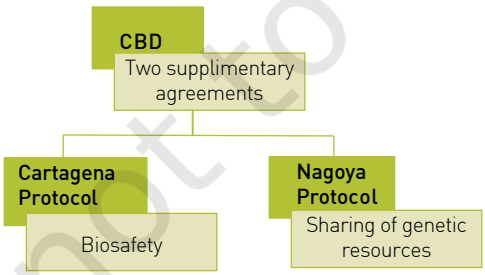

Fig 1. CBD and supplementary agreements

The historic Paris Agreement intends to combat climate change through reducing carbon emission. It aims at keeping the global temperature rise well below 2 degrees Celsius this century and also to strive further for 1.5 degrees Celsius above pre-industrial levels.

USA and Europe have successfully arrested the pollution level. During 1980-2014, the Gross Domestic Product (GDP) of the USA increased 147 per-cent, the population grew by 41 per cent and energy consumption grew 26 per cent. However, during the same period, total emissions of the six major air pollutants reduced by 63 per cent (EPA, 2016). This observation busted the myth that pollution cannot be checked without compromising with the economic growth.

Thus, apart from treaties, the future technologies give immense hope. A breakthrough in storing and transporting energy, improved nuclear safety and biotechnologically modified photosynthesis could change the game plan completely. Ambitious plans of generating green energy as well as increasing the efficiency in the use of energy (like use of LED lights) has successfully helped meet the demands of millions. Thus, the treaties, as well as the technologies have the potential to reduce the burden on the environment and planet.

Conclusions

The plants are indispensable for our existence. For developing sustainably we need to care for the plants and the environment. Educating the society about how to behave responsibly towards the environment is the core of education for sustainable

development. The education inspires in adopting new behaviours and practices to secure the future through addressing a variety of problems.

A small individual step may integrate globally to a sizeable result. Eating locally grown foods may help cut down on energy consumption significantly. If food wastage could be reduced through rational use and better distribution management, 14 per cent emission of the green house gases in 2050 would be avoided. As per an estimate, as much as 30-40 per cent of food produced is never used (Hic, et.al., 2016).

The climate change seems imminent if humankind takes it lying down. The extent of the climate change impacts will also depend on how different regions adapt to climate change. A wide spectrum of adaptation measures may be required to adapt to the climate change ranging from improved town planning to increase green spaces in residential area.The studies are required to develop resilient crops to withstand extreme weather and better health care to make the poor survive the climate shocks. Creation of a carbon sink through additional forest and tree cover may lower the carbon emissions.

World experience shows that adoption of cleaner technologies aid to the low carbon development. Success in cutting of emissions and reversal of pollution trends in certain regions of the world are some of the good signs.

Despite the threat of climate change looming large, the technological development, international treaties, national policies as well as individual efforts are going to bring about major differences. However, all this may begin with developing a new outlook towards the environment and forging a new human–plant relationship.

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