

Govt. Degree College Kilam
Department of Environmental Science
Study Material for BG 1st and 2nd Semester (CBCS)
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Credit III: Biodiversity and its Conservation

- 3.1. Biodiversity: definition, levels and values (commercial, ecological, social and aesthetic)
- 3.2 Threats to the biodiversity: Habitat loss, poaching of wildlife, man-wildlife Conflicts.
- 3.3 Concept of endemism and hot spots of biodiversity.
- 3.4 Conservation of biodiversity: In-situ and Ex-situ concepts.

Biodiversity: The term biodiversity is made of two words “**bio**” and “**diversity**”; “**bio**” means “**living**” and “**diversity**” means “**variety**”. So the variety or variability of organisms and ecosystem is referred as biodiversity. Before 1985 it was called as biological diversity. The term biodiversity was coined by **Walter G Rosen** in 1985. Biodiversity can also be defined as; “the variability among living organisms from all sources, including, ‘inter alia’, terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are a part”. This includes diversity within species, between species and of ecosystems. This definition was used in the United Nations Convention on Biological Diversity.

Levels of Biodiversity

Genetic Diversity: Genetic diversity occurs between the members of the same species. Within any given species there can be several varieties, strains or races which slightly differ from each other in one or more characteristics such as size, shape, resistance against diseases, pests, insects etc. and resilience to survival under adverse environmental conditions. Such variability in the genetic makeup among individuals within a single species is referred to as genetic diversity.

Species with more number of races, varieties and strains are considered to be rich and more diverse in its genetic organization. Genetic diversity is needed by any species to maintain its reproductive vitality, resistance to disease and the ability to adapt to changing conditions.

Species Diversity: The number of species of plants and animals that are present in a region constitute its species diversity. It includes full range of species from microorganisms to giant varieties of plants and animals e.g single celled bacteria and viruses etc. and multicellular plants, animals and fungi. This diversity is seen both in natural ecosystems and in agricultural

ecosystems. Some are richer in species than others. The species richness is measured by two popular indices known as Shannon weiner and Simpson index. At present scientists have been able to identify about 1.8 million species on earth. India is one among the nations that is rich in species diversity. Areas that are rich in species diversity are called hotspots of diversity.

Ecosystem diversity: It studies variation in the biological communities in which species live, exist and interact. Ecosystem diversity is the variety of biotic and abiotic components that interact with one another and it represents the collective response of a community of species to different environmental conditions. The overall diversity of any given area depends upon the range of habitats. It includes the diversity of the component habitats and are ranked as follows:

- Alpha diversity: diversity within a site or habitat.
- Beta diversity: Differences of diversity between habitats.
- Gamma diversity: Differences in the site diversity over a large area such as continent.

Introduction/meaning of biodiversity: Biodiversity is the variety of all living things; the different plants, animals and micro organisms, the genetic information they contain and the ecosystems they form. The variety and variability of organisms is referred to as biological diversity or biodiversity. Biological diversity or Biodiversity in short is the sum of all the different species of microorganisms, fungi, plants and animals living on earth and the variety of habitats in which they live. They hold an immense value for man and are central to the survival of human civilizations. The full range and extent of biodiversity is still not known, leave alone their greatest values and benefits.

The term biodiversity has been defined differently. The Global convention on biodiversity (CBD) has defined it as “the variability among living organisms from all sources including terrestrial, aquatic (fresh, estuarine and marine) and the ecological complexes of which they are a part. This includes diversity within species, between species and of ecosystems.”

Levels of Biodiversity:

Generally three hierarchical levels of biodiversity are recognized namely genetic diversity, species diversity and ecosystem diversity.

Genetic Diversity: Genetic diversity occurs between the members of the same species. Within any given species there can be several varieties, strains or races which slightly differ from each other in one or more characteristics such as size, shape, resistance against diseases, pests, insects etc and resilience to survival under adverse environmental conditions. Such variability in the genetic makeup among individuals within a single species is referred to as genetic diversity.

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Species diversity: Species diversity represents the variety of species in different habitats on earth or in other words we can say that species diversity refers to the total number of species i.e.

species richness of our earth. Species diversity can be measured on the basis of number of species in a region.

Currently about **1.9 million species** are known but this is thought to be a significant underestimate of the total member of species. It is estimated that the total number of species could be 5-30 million on our earth and one more estimate by UNEP (1993-94), the total number of species that might exist on earth range between 9-52 million.

Ecosystem Diversity: Ecosystem diversity and ecological diversity is the variety of biotic and abiotic components that interact with one another and it represents the collective response of a community of species to different environmental conditions.

An ecosystem develops its own characteristic community of living organisms based upon the availability of abiotic resources and conditions of the environment, so that is because different types of ecosystems represent they unique diversity each with a characteristic biotic community.

Values of Biodiversity

Biodiversity has a fundamental value to humans because we are so dependent on it for our cultural, economic, and environmental well-being. Biodiversity is vital to our biosphere's health, stability and its proper functioning. Biodiversity provide an enormous range of goods and other services, immediate as well as long term, material as well as spiritual and psychological which are vital to our well being. The global concern for the need to preserve biological diversity stems from its enormous significance and inestimable value to mankind. Our tendency to evaluate everything in terms of direct economic benefits or costs has resulted in the severe undervaluing of biodiversity in the past. Even now it is not possible to convert the potential benefits of biodiversity into monetary values for assessment. The values of the earth's biological resources can broadly be classified into following:

Direct Values: Also known as use value and commodity value and are assigned to the products harvested by people. The direct values include food resources like grains, vegetables, fruits which are obtained from plant resources and meat, fish, egg, milk and milk products from animal resources. These also include other values like medicine, fuel, timber, fiber, wool, wax, resin, and rubber, silk and decorative items. The direct values are of two types

Consumptive use value: These are the direct values where the biodiversity products can be harvested and consumed directly. Example food, fuel and drugs. These goods are consumed locally and do not figure in national and international market.

(a) Food : A major share of our food comes from domesticated crops and animals. Still we derive major of food from wild species. We obtain Grains, vegetables, fruits, nuts, condiments, tea-coffee, tobacco, liquor, oil from plants and meat, fish, egg, milk (and milk products), honey, etc. from animals.

(b) Fuel: Since ages forests have provided wood which is used as a fuel. Moreover fossil fuels like coal, petroleum, natural gas are also products of biodiversity which are directly consumed by humans. All through fossil fuels have productive use values.

(c) Drugs and medicines: The traditional medical practices like ayurveda utilize plants or their extracts directly. In allopathy, the pharmaceutical industry is much more dependent on nature products. Many drugs though having productive use values are derived from plants like (i) Quinine: - The famous anti-malarial drug is obtained from cinchona tree. (ii) Penicillin: - A famous antibiotic derived from penicillium, a fungus. (iii). Digitalis and Digitoxin from foxgloves have saved millions of heart patients. (iv). Recently vinblastin and vincristine- two anti cancer drugs have been obtained from Rosy Periwinkle plant which has anti cancer alkaloids.

Productive use values: These are the direct use values where the product is commercially sold in national and international markets. Many industries are dependent upon these values. Examples textile, leather, silk, pump, paper and pulp industry etc. although there is an international ban on trade of products from endangered species like tusks of elephants, wool from sheep, fur of many animals etc. these are traded in market and fetch a booming business.

Indirect values: Biodiversity provides indirect benefits to human beings which support the existence of biological life and other benefits which are difficult to quantify. There include social and culture values, ethical values, aesthetic values, option values and environment service values.

Social and cultural values: Many plants and animals are considered holy and sacred in India and are worshiped like tulsi, peepal, cow, snake etc. In Indian society great cultural value is given to forest and as such tiger, peacock and lotus are named as the national animal, bird and flower respectively.

Ethical: These values are related to conservation of biodiversity where ethical issue of "all life forms must be preserved" is laid down. There is an existence value which is attached to each species because biodiversity is valuable for the survival of human race. More over all species have a moral right to exist independent of our need for them.

Aesthetic value: There is a great aesthetic value which is attached to biodiversity. Natural landscape at undisturbed places are a delight to watch and also provide opportunities for recreational activities like bird watching, photography etc. It promotes ecotourism which further generates revenue by designing of Zoological parks, Botanical gardens, National parks, Wildlife sanctuaries etc.

Optional value: These values include the unexplored or unknown potentials of biodiversity.

Environment service value: - The most important benefits of biodiversity is maintenance of environmental services which include

- Carbon dioxide fixation through photosynthesis.
- Maintaining of essential nutrients by carbon, Oxygen, Nitrogen, Sulphur, and Phosphorous Cycles.
- Maintaining water cycle and recharging of ground water.
- Soil formation and protection from erosion.
- Regulating climate by recycling moisture into atmosphere.

- Detoxification and decomposition of waste.

Threats to Biodiversity:

Biodiversity is diminished or destroyed in a number of ways either by natural changes or by human disruption. Increasing population pressure and over-exploitation of the biotic resources is taking their toll on biodiversity. Biodiversity losses can be attributed to the resource demands of our rapidly growing human population. In modern times the human population has increased from 1 billion in 1900 to over 7 billion today. Like other living beings, we use natural resources to survive but we are far more resourceful and destructive to other life forms than any other species previously known. As the world's human population increases all the organisms on earth (including ourselves) must share the same limited resources (food, water, space). Yet there is less and less natural habitat remaining as land is developed for human habitation and activities.

Any disturbance in a natural ecosystem tends to reduce its biodiversity. The activities or reason resulting in the loss of biodiversity are regarded as the threats to biodiversity as under:

1. Habitat loss and fragmentation: is considered by conservation biologists to be the primary cause of biodiversity loss. Clearance of native vegetation for agriculture, housing, timber and industry as well as draining wetlands and flooding valleys to form reservoirs, destroys these habitats and all the organisms in them. In addition, this destruction can cause remaining habitats fragmented and so too small for some organisms to persist or fragments may be too far apart for other organisms to move between. Sometimes habitat fragmentation occurs due to construction of roads, towers and canals. Habitat fragmentation divides populations into isolated groups that not only limit the potential of species for dispersal and colonization but also reduces the foraging ability of animals. These isolated, small, scattered populations are increasingly vulnerable to inbreeding depression, high infant mortality and susceptible to environmental hardships and consequently in the end, possible extinction.

2. Invasive alien species: They are the second greatest threat to biodiversity worldwide, whether introduced for any purpose or accidentally. Non- native species can cause severe problems in the ecosystems they invade, from affecting individuals to causing huge changes in ecosystem functioning and the extinction of many species. Virtually all ecosystems worldwide have suffered invasion by the main taxonomic groups. This problem possibly gets worsened by climate change and an increase in global trade and tourism. As well as the risks to human health alien species inflict massive economic costs to agriculture, forestry, fisheries and other human activities.

For example introduction of Nile Perch from North in Lake Victoria, Africa's largest lake has driven almost half of the 400 original fish species of the lake to near extinction.

3. Pollution: Pollution is currently poisoning all forms of life, both on land and in water and contributing to climate change. Any chemical in the wrong place or in the wrong concentration can be considered a pollutant. Transport, industry, construction, extraction, power generation and agro forestry all contribute pollutants to the air, land and water. These chemicals can directly affect biodiversity or lead to chemical imbalances in the environment that ultimately kill individuals, species and habitats.

4. Climate change: Climate change brought about by emissions of greenhouse gases when fossil fuels are burnt is making life uncomfortably hot for some species and uncomfortably cold for others. This can lead to change in the abundance and distribution of individual species around the globe and will affect the crops we grow, cause a rise in sea levels and problems to many coastal ecosystems. In addition the climate is becoming more unpredictable and extreme devastating events are becoming more frequent.

5. Over exploitation and poaching: Over exploitation by humans causes massive destruction to natural ecosystems. Exploitation of biodiversity occurs for good (e.g. fish), construction (e.g. trees), industrial products (e.g. animals, blubber, skins), the pet trade (e.g. reptiles, fish, orchids, fashion e.g. (fur, ivory) and traditional medicines (e.g. rhino horn). Selective removal of an individual species can unbalance ecosystems and all other organisms within them. In addition the physical removal of one species often harms other (e.g. fishing by catches). Poaching which means illegal /unlawful trade of wild plants and animals through hunting, harvesting, fishing or trapping is also causing loss of biodiversity at a very fast rate. The lure of spectacular profits drives the illegal trade in endangered species and their products. In spite of laws prohibiting the trade, consumers all over the world are willing to pay 95, 000 dollars for a Bengal tiger coat. Similarly a coat made of South American Ocelot costs 40000 dollars. Poaching contributes to loss of biodiversity. Poaching is of 3 types listed below:

- i **Subsistence poaching:** This refers to killing animals for survival.
- ii **Commercial poaching:** This refers to hunting animals in order to sell their products.
- iii **Recreational or Sport or Game poaching:** This refers to the hunting of wild animals for recreational purposes or for fun.

Man- wildlife conflict: Man- wildlife occurs when growing human populations overlap with established wildlife territory creating reduction of resources or life to some people and or wild animals.

Human wildlife conflict is defined by the World Wide Fund for Nature (WWF) as "any interaction between humans and wildlife that results in negative impacts on human social, economic or cultural life, on the conservation of wildlife populations, or on the environment." As human populations expand into wild animal habitats, natural wildlife territory is displaced. Reduction in the availability of natural prey/food sources leads to wild animals seeking alternate sources. Conflicting situations with wild life starts causing immense damage and danger to man. Example: In Sambalpur, Orissa 195 humans are killed in last 5 years by elephants and in retaliation villagers killed 98 elephants and badly injured more than 30 elephants. Similarly incidents with tigers, leopards *etc.* are in news. Shrinking forest cover, human encroachment, ill and weak animals, lack of food (one adult elephant needs 200 kg green fodder and 150 kg of clean water) for animals, protecting villagers by putting electric fence are the main reasons for such happenings. As the compensation by government is not enough, conflicts occur between forest department and villagers.

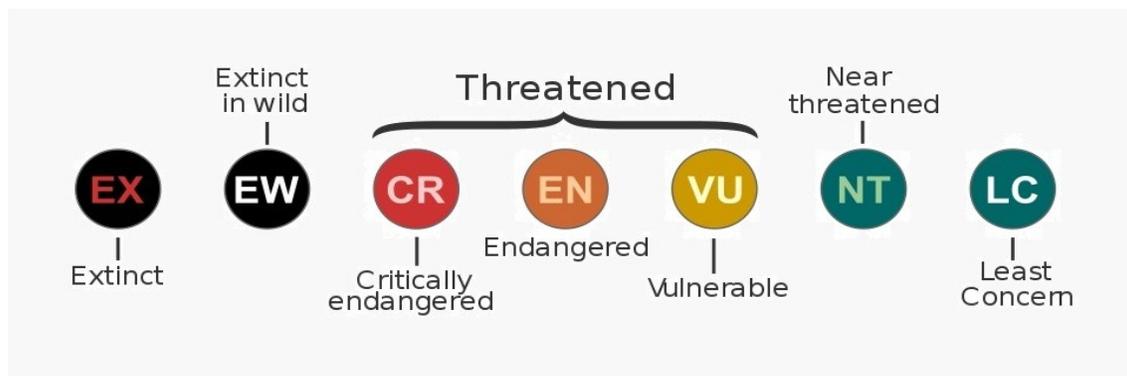
Human–wildlife conflict occurs with various negative results. The major outcomes of human-wildlife conflict are:

- Injury and loss of life of humans and wildlife.
- Crop damage, livestock depredation, predation of managed wildlife stock.
- Damage to human property.
- Trophic cascades.
- Destruction of habitat.
- Collapse of wildlife populations and reduction of geographic ranges.

Threatened Species: The international union for conservation of nature and natural resources (IUCN) publishes the Red Data Book which contains list of species whose continued existence is threatened. Species are classified into different categories of perceived risk. Red data books are now being published in many different countries and provide useful information on the threat status of the species. IUCN develops different categories of species based on certain criteria.

- The present and past distribution.
- Decline in the number of population in Course of time.
- Abundance and quality of natural habitat.
- Biological and potential value of species.

IUCN Red List of Threatened Species recognizes several categories of species status as under:



1. Extinct (EX), a status applied to species in which the last individual has died or where systematic and time-appropriate surveys have been unable to log even a single individual. Examples, Passenger Pigeon, Dodo Bird.
2. Extinct in the Wild (EW), a category containing those species whose members survive only in captivity or as artificially supported populations far outside their historical geographic range. Examples, Golden Toad, Franklinia Plant. South China tiger, Alagoas curassow

3. Critically Endangered (CR), a category containing those species that possess an extremely high risk of extinction as a result of rapid population declines of 80 to more than 90 percent over the previous 10 years (or three generations), a current population size of fewer than 50 individuals, or other factors. Examples, Bengal Tiger, Arakan forest turtle, Javan rhino, Brazilian merganser
4. Endangered (EN), a designation applied to species that possess a very high risk of extinction as a result of rapid population declines of 50 to more than 70 percent over the previous 10 years (or three generations), a current population size of fewer than 250 individuals, or other factors. Examples, blue whale, snow leopard, African wild dog.
5. Vulnerable (VU), a category containing those species that possess a very high risk of extinction as a result of rapid population declines of 30 to more than 50 percent over the previous 10 years (or three generations), a current population size of fewer than 1,000 individuals, or other factors. Examples: cheetah, gaur, lion, wolverine
6. Near Threatened (NT), a designation applied to species that are close to becoming threatened or may meet the criteria for threatened status in the near future. Examples: blue-billed duck, solitary eagle, small-clawed otter
7. Least Concern (LC), a category containing species that are pervasive and abundant after careful assessment. Examples: brown rat, Nootka cypress, wood pigeon
8. Data Deficient (DD), a condition applied to species in which the amount of available data related to its risk of extinction is lacking in some way. Consequently, a complete assessment cannot be performed. Thus, unlike the other categories in this list, this category does not describe the conservation status of a species
9. Not Evaluated (NE), a category used to include any of the nearly 1.9 million species described by science but not assessed by the IUCN.

Endemic species:

An endemic species is one whose habitat is restricted to a particular area. The term could refer to an animal, a plant, a fungus, or even a microorganism. As such they are of conservation concern because they are not widespread and may be confined to only one or two protected areas.

India is quite rich in biodiversity endemism. About 33% of the country's flora is endemic and are concentrated mainly in the north east, Western Ghats, North West Himalaya and the Andaman and Nicobar islands. Similarly 62% of the known amphibian species and 50% of the lizards of the country are endemic with the majority occurring in the western- Ghats also a hotspot of biodiversity. Examples of endemic Flora species are

1. Sapria Himalayana
2. Ovaria Lurida
3. Nepenthis khasiana etc

Endemic fauna of significance in the Western Ghats are:

1. Lion tailed macaque
2. Nilgiri langur
3. Brown palm civet and
4. Nilgiri tahr

Exotic or non- native or alien species:

Exotic species are those organisms introduced into habitats where they are not native either deliberately or accidentally. Invasive exotic species are organisms not native to a region and whose introduction causes economic or environmental harm or harm to human health. In their natural habitats these organisms develop stable populations and complex relationships with other species. When removed from the predators, parasites, diseases and competitors that have kept their numbers in check, species introduced into new habitats often over run their new home and crowd out native species once established.

Humans are connected to most exotic species introductions. As people developed modes of transportation that allowed rapid and easy movement over long distances, they began to travel to new areas. Non- native species can cause severe problems in the ecosystems they invade, from affecting individuals to causing huge changes in ecosystem functioning and the extinction of many species. Virtually all ecosystems worldwide have suffered invasion by the main taxonomic groups. This problem possibly gets worsened by climate change and an increase in global trade and tourism. For example:

- Introduction of Nile Perch from North in Lake Victoria, Africa's largest lake has driven almost half of the 400 original fish species of the lake to near extinction.
- Parthenium hysterophorus (Congress grass- a tropical American weed) has invaded many of the vacant areas in cities, towns and villages in India leading to removal of the local plants and the dependent animals.
- Water hyacinth clogs lakes and riversides and threatens the survival of many aquatic species. This is common in Indian plains.

Hotspots of Biodiversity: Areas which exhibit high species richness as well as high species endemism are termed as hotspots of biodiversity. The hotspot of biodiversity concept was first introduced in ecology by a British ecologist Norman Myers in 1988. Conservation International has identified these biologically rich areas under the greatest threats of destruction as biodiversity hotspots. Hotspots of biodiversity are identified on the basis of three criteria as follows:

- The number of species present.
- The degree of threats they face.
- Number of endemic species found in ecosystem.

Thus we can say that hotspots of biodiversity are such areas on the surface of earth which have high species richness as well as high species endemism. Currently there are 35 hotspots of biodiversity in the world which support nearly 60% of the world's animal species, with a very high share of endemic species. There are 49,555 endemic species of higher plants that is 20% of the world's total plant species. India has four hotspots of biodiversity namely Northeast India, Western Ghats, Himalayas and Andaman & Nicobar Islands. Among the endemic species of India, a large portion is present in these areas. The Andaman & Nicobar Islands alone have as many as 2200 species of flowering plants and 120 species of ferns. 63% of Indian mammals are found in northeast. The northeast states have 1500 endemic plant species. A major portion of amphibian and reptile species are in Western Ghats, which is also a habitat for 1500 endemic plant species.

Conservation of Biodiversity: Conservation may be defined as the management and sustainable use of natural environment and natural resources for ethical reasons and the benefits of humanity. Conservation of biodiversity mainly centers upon the wildlife conservation. The wildlife can be conserved by protecting both the animal's life and plants. In this regard, following two approaches are adopted to conserve the wildlife in protected habitats.

1. In- situ conservation
2. Ex-situ conservation

1. In-situ Conservation: It can be defined as the conservation of plants and animals in their native ecosystems. This type of conservation is applicable through protection of plants and animals in their natural ecosystems. The concept of protected areas falls under this category e.g. National parks, Wildlife sanctuaries and biosphere reserves. In India there are 103 national parks, 515 wildlife sanctuaries and 18 biosphere reserves meant for in situ conservation.

National park: It is an area dedicated for the conservation of wildlife along with its environment. It is also meant for enjoyment through tourism but without impairing the environment. Grazing of domestic animals, all private rights and forest activities are prohibited within a national park. Each national park aims at conservation of some particular species of wildlife along with others. The first national park developed in India is Hailey national park in 1936 which is now known as Jim corbet national park. Some famous national parks of India are as follows:

National park	State	Important Wildlife
Kaziranga	Assam	Rhino
Corbet	U.P	Tiger
Dachigam	Srinagar (J&K)	Hangul
Periyar	kerela	Tiger, Elephant
Gir national park	Gujrat	Lion

Wildlife sanctuaries are also protected areas where killing, hunting, shooting or capturing of wildlife is prohibited except under the control of highest authority. The private ownership rights are permissible and forestry operations are also permitted to an extent that they do not

affect the wildlife. India has 515 wildlife sanctuaries meant for in situ conservation. Among these 48 tiger reserves are governed by project tiger and are of special importance in the conservation of tiger. Some important wildlife sanctuaries are:

Gana Bird Sanctuary	Rajasthan	300 Species of birds
Wild ass sanctuary	Gujrat	Wild ass
Hazaribagh sanctuary	Bihar	Tiger
Nandni sanctuary	Jammu	Monkey

Biosphere reserves aim at conserving the biological diversity and genetic integrity of plants, animals and microorganisms in their totality as part of the natural ecosystems, so as to ensure their self-perpetuation and unhindered evolution of the living resources. In biosphere reserves the whole area is protected and not any one particular plant or animal species. Currently there are 18 major biosphere reserves in India which are meant for in situ conservation.

1. **Ex situ Conservation:** Ex Situ Conservation or Of-Site Conservation means conservation of endangered plants and animal species away from their natural habitat under human supervision and care. Ex situ conservation involves maintenance and breeding of endangered species of plants and animals under partially or wholly controlled conditions in zoos, gardens, nurseries and laboratories. In ex situ conservation the endangered animal species are collected and bred under desired conditions in zoos, aquaria etc. While plant species are maintained in botanical gardens, seed banks, gene banks etc.

For the present discussions, following ex-situ conservation means have been taken into consideration.

i **Seed gene bank:** These are cold storages where seeds are kept under controlled temperature and humidity for storage and this is easiest way to store the germ plasma of plants at low temperature. Seeds preserved under controlled conditions (minus temperature) remain viable for long durations of time.

ii **Gene bank:** Genetic variability also is preserved by gene bank under normal growing conditions. These are cold storages where germ plasma is kept under controlled temperature and humidity for storage; this is an important way of preserving the genetic resources.

iii **Tissue culture:** Cryopreservation of disease free meristems is very helpful. Long term culture of excised roots and shoots are maintained. Meristem culture is very popular in plant propagation as it is virus and disease free method of multiplication.

iv **Botanical gardens:** A botanical garden is a place where flowers, fruits and vegetables are grown. The botanical gardens provide beauty and calm environment. Most of them have started keeping exotic plants for educational and research purposes.

v **Zoological Gardens:** In zoos wild animals are maintained in captivity and conservation of wild animals (rare, endangered species). In world there are about 800 zoos. Such zoos have about 3000 species of vertebrates.

