Chapter - IV

Ecosystem Dynamics

An ecosystem is a community of living organisms (plants, animals, and microbes) existing in conjunction with the nonliving components of their environment (air, water, and mineral soil), interacting as a system. These biotic and abiotic components are linked together through nutrient cycles and energy flows. As ecosystems are defined by the network of interactions among organisms, or between organisms and their environment, they can be of any size, but usually encompass specific, limited spaces.

Internal and External Factors

Ecosystems are dynamic entities controlled both by external and internal factors. External factors, such as climate and the parent material that forms the soil, control the overall structure of an ecosystem and the way things work within it, but are not themselves influenced by the ecosystem. While the resource inputs are generally controlled by external processes, the availability of these resources within the ecosystem is controlled by internal factors such as decomposition, root competition, or shading. Other internal factors include disturbance, succession, and the types of species present. From one year to another, ecosystems experience variation in their biotic and abiotic environments. A drought, an especially cold winter, and a pest outbreak all constitute short-term variability in environmental conditions. Animal populations vary from year to year, building up during resource-rich periods, but crashing as the food supply becomes scarce.

Equilibrium is the steady state of an ecosystem where all organisms are in balance with their environment and with each other. In equilibrium, any small changes to the system will be balanced by negative feedback, allowing the system to return to its original state.

Resistance and Resilience

In ecology, two parameters are used to measure changes in ecosystems: resistance and resilience. Resistance is the ability of an ecosystem to remain at equilibrium despite disturbances. Resilience is the speed at which an ecosystem recovers to equilibrium after being disturbed. Humans may impact the nature of an ecosystem to such a degree that the ecosystem can lose its resilience entirely. In these cases, external human influences can lead to the complete destruction or irreversible altering of the ecosystem equilibrium.

Human intervention in ecosystem equilibrium

The Australian Aboriginal practice of "Fire-stick farming" has fundamentally modified Australian ecosystems. The legacy of this practice over long periods has resulted in forests being converted to grasslands. In this example, the forests became less and less resilient over time until the fundamental system equilibrium had changed.

The Sin Nombre Virus: Ecosystem Dynamics in a Human Population

In 1993, a change in ecosystem dynamics caused a disease outbreak in a human population. In May of 1993, an unexplained pulmonary illness struck inhabitants of the southwestern United States in an area shared by Arizona, New Mexico, Colorado and Utah known as "The Four Corners. " A young, physically fit Navajo man suffering from shortness of breath was rushed to a hospital in New Mexico and died rapidly. After further investigation, state officials located another five young, healthy people who had all died after acute respiratory failure.

When laboratory tests failed to identify the disease causing the deaths, New Mexico state health officials notified the Centers for Disease Control (CDC), the United States government agency responsible for managing potential epidemics. As additional cases

of the disease were reported in the following weeks, physicians and scientists worked intensively to narrow down the list of possible causes. Virologists at the CDC linked the pulmonary syndrome with a virus - a previously unknown type of hantavirus. The hantavirus became known as *Sin Nombre*, the virus "with no name. "

Sin Nombre hantavirus

After a series of sudden deaths in 1993, scientists in the Four Corners area of the Southwestern United States rushed to determine the cause. They isolated a previously unknown hantavirus that caused pulmonary failure or Hantavirus Pulmonary Syndrome (HPS). The new virus was named Sin Nombre, or virus with "no name. "

Although they identified the virus as the cause of the disease, researchers did not understand how it was transmitted. The researchers trapped and examined rodents that lived in and around the homes of the victims, and found that almost 30% of the deer mice were infected with the Sin Nombre hantavirus. The virus had been transmitted to humans via aerosolized mouse droppings, and a dramatic increase in the deer mouse population increased human infection rates.

The Four Corners area had experienced a drought until early 1993, when there were heavy snows and rainfall. The end of the drought caused an increase in vegetation, and particularly pinon nut production. With the sudden increase in food supply, the local deer mice population exploded and reproduced so rapidly that there were ten times more mice in May 1993 than there had been in May of 1992. The higher population of deer mice meant more mouse droppings and more opportunities to transmit hantavirus to humans.

Ecosystem dynamics can affect human populations

The Four Corners area had been in a drought for several years. In early 1993, the rainfall caused an increase in vegetation, which caused an increase the local deer mice population. Hantavirus infected the high deer mouse population and was quickly transmitted to humans via aerosolized mouse droppings.

As part of the effort to locate the source of the virus, researchers located and examined stored samples of lung tissue from people who had died of unexplained lung disease. Some of these samples showed evidence of previous infection with Sin Nombre virus, indicating that the earlier cases of the disease had not been recognized. The Navajo Native Americans recognize a similar disease in their medical traditions, and associate its occurrence with mice.

What is an Ecosystem

Ecosystems are vital to survival of all living things, including us, humans. In fact the break in this natural and balanced network of living things interacting with their environment can have irreparable damage to all other members of the network.

Ecosystems can exists in unique classes, and may not have direct relationships with other ecosystems, but all are joined together by abiotic factors such as climate, moisture, temperature and the like. The importance of ecosystems are usually described as ecosystem services.

An ecosystem is a biological community, made of some life forms interacting with their environment. Living members of this community are known as biotic factors, and the non-living things form the abiotic factors. An example of a basic ecosystem is puddle. In there you will find some biotic factors such as green plants, algae, some fishes and tadpoles, worms and water insects and birds hovering over the puddle.

These living things cannot exist without the abiotic factors such as water, sun, soils, rocks, temperatures and other environmental gases inside and outside of the puddle.

Ecosystems are the basis of energy flow, together with the recycle of carbon and nitrogen.

Carbon is very important to all food chains, because living tissue contain carbon. This carbon comes from the atmosphere, and it is produced mainly by respiration of animals, the decomposition of organic matter and the combustion of fuels. Green plants absorb this carbon from the air for use in glucose preparation (as plant food). The glucose (energy) produced is passed stored in the plants. As animals consume them, the carbon is passed on to them, and the rest given off into the air when plants die.

In a similar way, nitrogen, which makes up about 78% of the air, is converted into nitrate by lightening, root nodules and nitrogen fixing bacteria. Plants use up the nitrates in the soil to build up proteins. Proteins are passed onto animals that consume green plants. Nitrates are passed on back to the soils when animals poop, or die and decompose. In the soils, they are broken down by denitrifying bacteria and nitrogen gas is released back into the atmosphere.

Ecosystems survive with carbon and nitrogen cycles, and they are all connected perfectly in something we call food chains.

Benefits of ecosystems

The interaction of living things depending on each other and relating to their environments has immense benefits in terms of the health and spiritual wellbeing of humans, the health of members of the ecosystem themselves, as well as the environment. Living things do not exist in isolation. They depend on abiotic factors too. The benefit of ecosystems therefore is not exclusive to living things. So, what is the role of ecosystems?

A. Supportive

Ecosystems provide a supporting role for all its members. In this role, living members serve as food for others, and their produce and residue serve as nutrients to soils and gases to the atmosphere. This makes soil nutrient cycle, carbon and oxygen cycle and water cycle possible and also for living things to continue procreation.

B. Provision

Ecosystems are also the source of all foods, store of all energy, fibre, genetic resources, medicines, fresh water and minerals. All natural resources that humans depend on, has its source from ecosystems.

C. Regulation

The function of a healthy ecosystem ensures that there is balance and regulation in the climate, regulation in fresh water, soils, rocks, and atmosphere. They function to regulate animals and plant diseases and ensure that biodiversity is preserved.

D. Spiritual Value

Perhaps not exclusive to humans, ecosystems provide humans with deeper spiritual enrichment and cognitive development. The wonder and breathtaking properties of healthy ecosystems has recreational effects, as well as aesthetic value to us. From land the remotest places on earth to the deepest places in the oceans, there are millions of life forms that function in harmony, and provide humans with meditative and healing benefits.

Threats to Ecosystems

Anything that attempts to alter the balance of the ecosystem potentially threatens the health and existence of that ecosystem. Some of these threats are not overly worrying as they may be naturally resolved provided the natural conditions are restored. Other factors can destroy ecosystems and render all or some of its life forms extinct. Here are a few:

Habitat Destruction

Economic activities such as logging, mining, farming and construction often involve clearing out places with natural vegetative cover. Very often, tampering with one factor of the ecosystem can have a ripple effect on it and affect many more or all other factors of that ecosystem. For example, clearing a piece of forest for timber can expose the upper layers of the soil to the sun's heat, causing erosion and drying. It can cause a lot of animals and insects that depended on the shade and moisture from the tree to die or migrate to other places.

Pollution

Water, land and air pollution all together play a crucial role in the health of ecosystems. Pollution may be natural or human caused, but regardless they potentially release destructive agents or chemicals (pollutants) into the environments of living things. “In a lake, for example, it can create havoc on the ecological balance by stimulating plant growth and causing the death of fish due to suffocation resulting from lack of oxygen. The oxygen cycle will stop, and the polluted water will also affect the animals dependent on the lake water” Source: Study the effect of pollution on an ecosystem, WWF.

Eutrophication

This is the enrichment of water bodies with plant biomass as a result of continuous inflow of nutrients particularly nitrogen and phosphorus. Eutrophication of water fuels excessive plant and algae growth and also hurts water life, often resulting in the loss of flora and fauna diversity. “The known consequences of cultural eutrophication include blooms of blue-green algae (i.e., cyanobacteria, Figure 2), tainted drinking water supplies, degradation of recreational opportunities, and hypoxia. The estimated

cost of damage mediated by eutrophication in the U.S. alone is approximately $2.2 billion annually (Dodds et al. 2009) Source: Eutrophication: Causes, Consequences, and Controls in Aquatic Ecosystems, Michael F. Chislock

Invasive species

Any foreign specie (biological) that finds its way into an ecosystem, either by natural or human introduction can have an effect on the ecosystem. If this alien has the ability to prey on vulnerable and native members of that ecosystem, they will be wiped out, sooner or later. One devastating impact of introducing alien Nile Perch and Nile Tilapia into Lake Victoria in the 1970s was the extinction of almost half of the 350+ endemic species of fish in the cichlid family.

Overharvesting

Fish species, game and special plants all do fall victim from time to time as a result of over harvesting or humans over dependence on them. Overharvesting leads to reduction in populations, community structures and distributions, with an overall reduction in recruitment. Lots of fish species are know to have reached their maximum exploitation level, and others will soon be. “For example Oreochromis karongae is one of the most valuable food fishes in Malawi, but populations collapsed in the 1990s due to overfishing, and it is now assessed as Endangered.” Source: IUCN, Major Threats

UV Radiation

The sun’s rays play an important role in living things. UV rays come in three main wavelengths: UVA, UVB and UVC, and they have different properties. UVA has long wavelengths and reaches the earth’s surface all the time. It helps generate vitamin D for living things. UVB and UVC are more destructive and can cause DNA and cell damage to plans and animals. Ozone depletion is one way that exposes living things to UVB and UVC and the harm caused can wipe lots of species, and affect ecosystems members including humans.

Preserving Ecosystems

Considering the threats facing ecosystems, we can begin to appreciate the importance of policy, rules and regulation in human activity towards ecosystems. Here are a few ways we can ensure the health and smooth functioning of ecosystems.

Habitat preservation

Economic activity should be managed and made sustainable. Tree cutting for example must be regulated and best practices enforced.

Invasive Species

In many of the tragedies that ecosystems have faced with the introduction of alien species, humans have caused that. It is crucial that proper inspection, regulation, research and monitoring systems are in place to protect weaker native species in ecosystems, if new species are to be introduced.

Eutrophication

One big cause of eutrophication is the runoff of surface chemicals and fertilizers applied to plants during farming. Whiles we need food to survive, it is important that we encourage organic planting as against the heavy use of chemicals. Sewage also need to be inspected and monitored such that when the waste water is deposited into

water bodies, it is properly filtered and treated to reduce the organic nutrient content.

Pollution

Air and land pollution together have effects on water bodies too. Acid rains and chemical runoff all affect life forms in the water. Oils that are discharged into water bodies can have a devastating effect. “In aquatic ecosystems, air pollution acidifies surface waters, reducing their ability to sustain native fish. In estuaries and coastal waters, it contributes to nutrient over-enrichment, producing algal blooms, foul smells and low oxygen levels. It also causes mercury to accumulate in aquatic food webs, threatening the health of both people and wild animals”

Ozone

Ozone is a secondary pollutant. It is the result of the formation of precursors nitrogen oxides and Volatile Organic Compounds (VOC). Biomass burning produces this. It is known that forest cover act as a net sink of ozone. It is therefore important that we preserve natural vegetative covers on earth and invest in energy forms that reduce the emissions of VOCs.

Types of ecosystems

This means that these **ecosystems** have a high density of living organisms. The different **types** of forest **ecosystems** are tropical evergreen forest, tropical deciduous forest, temperate evergreen forest, temperate deciduous forest and taiga.

Different Types of Ecosystems

There are essentially two kinds of ecosystems; Aquatic and Terrestrial. Any other sub-ecosystem falls under one of these two headings.

Terrestrial ecosystems

Terrestrial ecosystems can be found anywhere apart from heavily saturated places. They are broadly classed into:

The Forest Ecosystems

They are the ecosystems in which an abundance of flora, or plants, is seen so they have a big number of organisms which live in relatively small space. Therefore, in forest ecosystems the density of living organisms is quite high. A small change in this ecosystem could affect the whole balance, effectively bringing down the whole ecosystem. You could see a fantastic diversity in the fauna of the ecosystems, too. They are further divided into:

- **Tropical evergreen forest:** These are tropical forests that receive a mean rainfall of 80 for every 400 inches annually. The forests are characterised by dense vegetation which comprises tall trees at different heights. Each level is shelter to different types of animals.
- **Tropical deciduous forest:** There, shrubs and dense bushes rule along with a broad selection of trees. The type of forest is found in quite a few parts of the world while a large variety of fauna and flora are found there.
- **Temperate evergreen forest:** Those have quite a few number of trees as mosses and ferns make up for them. Trees have developed spiked leaves in order to minimize transpiration.
- **Temperate deciduous forest:** The forest is located in the moist temperate places that have sufficient rainfall. Summers and winters are clearly defined and the trees shed the leaves during the winter months.
- **Taiga:** Situated just before the arctic regions, the taiga is defined by evergreen conifers. As the temperature is below zero for almost half a year, the remainder of the months, it buzzes with migratory birds and insects.

The Desert Ecosystem

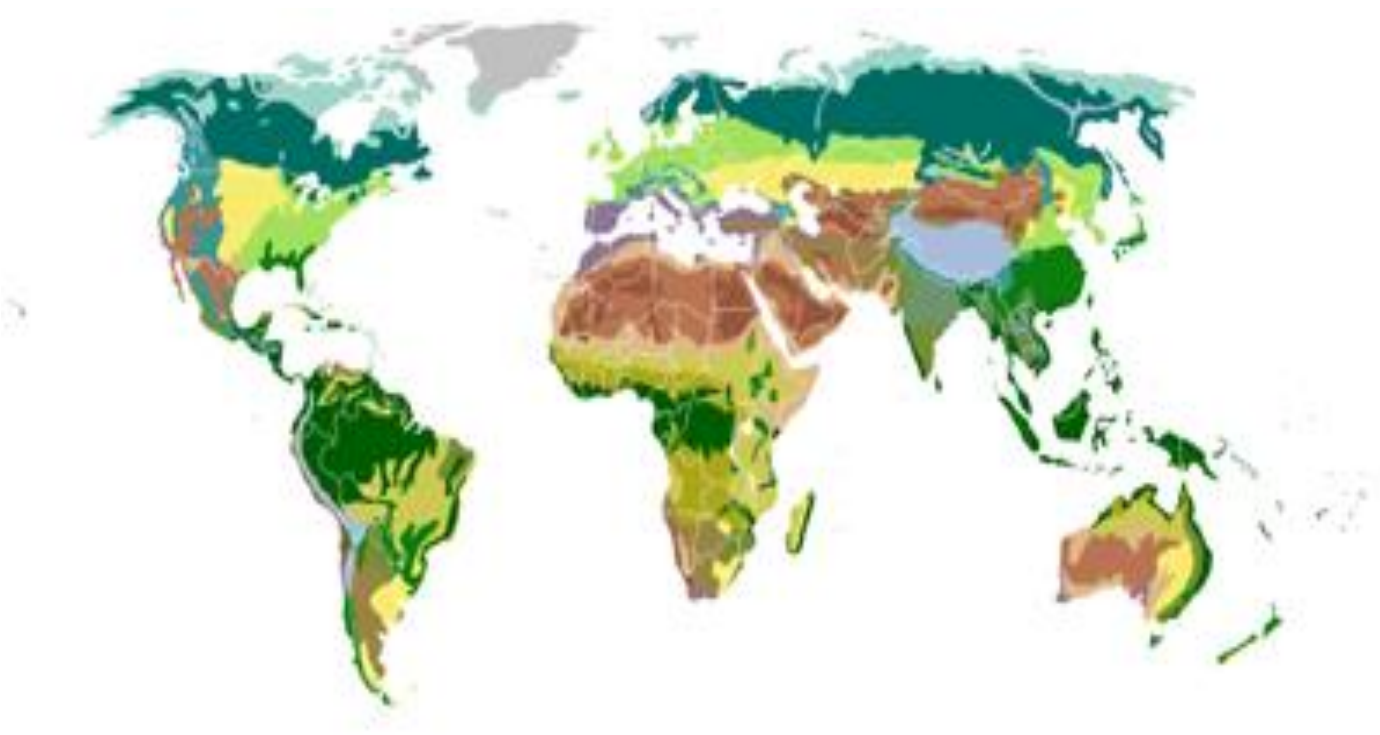
Desert ecosystems are located in regions that receive an annual rainfall less than 25. They occupy about 17 percent of all the land on our planet. Due to the extremely high temperature, low water availability and intense sunlight, fauna and flora are scarce and poorly developed. The vegetation is mainly shrubs, bushes, few grasses and rare trees. The stems and leaves of the plants are modified in order to conserve water as much as possible. The best known desert ones are the succulents such as the spiny leaved cacti. The animal organisms include insects, birds, camels, reptiles all of which are adapted to the desert (xeric) conditions.

The Grassland Ecosystem

Grasslands are located in both the tropical and temperate regions of the world though the ecosystems vary slightly. The area mainly comprises grasses with a little number

of trees and shrubs. The main vegetation includes grasses, plants and legumes that belong to the composite family. A lot of grazing animals, insectivores and herbivores inhabit the grasslands. The two main kinds of grasslands ecosystems are:

1. **Savanna:** The tropical grasslands are dry seasonally and have few individual trees. They support a large number of predators and grazers.
2. **Prairies:** It is temperate grassland, completely devoid of large shrubs and trees. Prairies could be categorized as mixed grass, tall grass and short grass prairies.



The Mountain Ecosystem

Mountain land provides a scattered and diverse array of habitats where a large number of animals and plants can be found. At the higher altitudes, the harsh environmental conditions normally prevail, and only the treeless alpine vegetation can survive. The animals that live there have thick fur coats for prevention from cold and hibernation in the winter months. Lower slopes are commonly covered with coniferous forests.

Aquatic Ecosystems

The aquatic ecosystem is the ecosystem found in a body of water. It encompasses aquatic flora, fauna and water properties, as well. There are two main types of aquatic ecosystem - Marine and Freshwater.

The Marine Ecosystem

Marine ecosystems are the biggest ecosystems, which cover around 71% of Earth's surface and contain 97% of out planet's water. Water in Marine ecosystems features in high amounts minerals and salts dissolved in them. The different divisions of the marine ecosystem are:

- Oceanic: A relatively shallow part of oceans which lies on the continental shelf.
- Profundal: deep or Bottom water.
- Benthic Bottom substrates.
- Inter-tidal: The place between low and high tides.
- Estuaries
- Coral reefs
- Salt marshes
- Hydrothermal vents where chemosynthetic bacteria make up the food base.

Many kinds of organisms live in marine ecosystems: the brown algae, corals, cephalopods, echinoderms, dinoflagellates and sharks.

The Freshwater Ecosystem

Contrary to the Marine ecosystems, the freshwater ecosystem covers only 0.8% of Earth's surface and contains 0.009% of the total water. Three basic kinds of freshwater ecosystems exist:

- Lentic: Slow-moving or till water like pools, lakes or ponds.
- Lotic: Fast-moving water such as streams and rivers.
- Wetlands: Places in which the soil is inundated or saturated for some lenghty period of time.

The ecosystems are habitats to reptiles, amphibians and around 41% of the world’s fish species. The faster moving turbulent waters typically contain a greater concentrations of dissolved oxygen, supporting greater biodiversity than slow moving waters in pools.

Types of Ecosystems

- There are many types of ecosystems on earth.
- Major classes of relatively contained ecosystems are called Biomes.
- There are 3 Major classes of ecosystems

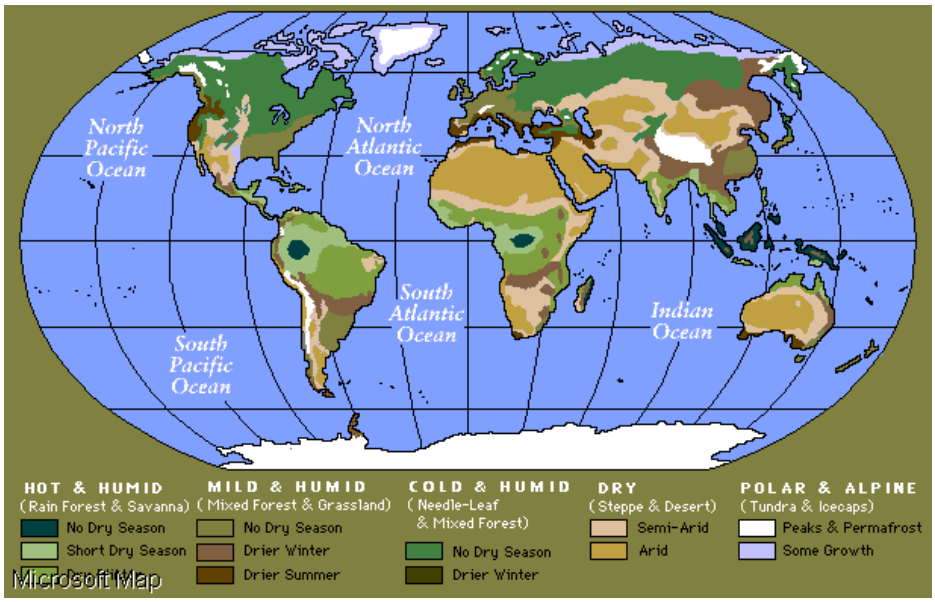
1. **Freshwater Ecosystems**
2. **Terrestrial Ecosystems**
3. **Ocean Ecosystems**

Freshwater ecosystems:

- Relatively small in area ~ 1.8% of earth's surface
- Support many species of life including fish, amphibians, insects and plants.
- Base of food-web is found in freshwater Plankton (small microscopic organisms)

Terrestrial Ecosystems:

- Many & diverse types of ecosystems. There are seven major types.
- Location usually dependent on the latitude of the area, and amount of precipitation



types & locations of biomes

Types:

1. **Tropical Rain Forest**

- Precipitation - 250cm/year
- Little temp. variation/abundant moisture
- Contains more species than other biomes.

tropical rain forest

1. **Savannas**

   Precipitation 90-150cm/year

   Open, widely spaced trees, seasonal rainfall

   Parts of Africa, South America & Australia

3. **Deserts**

   Precipitation 20cm/year

   Dry, sparce vegetation; scattered grasses

   Parts of Africa, Asia, Australia, North America

Desert

1. **Temperate Grasslands**

   Precipitation: 10-60cm/year

   Rich soil; tall dense grasses

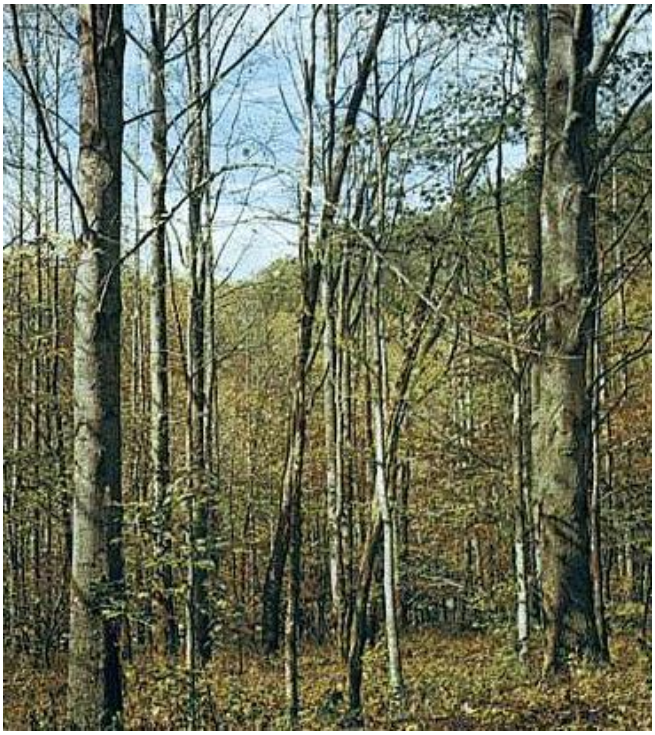
   Central North America; Central Asia

2. **Deciduous forests**

   75-250cm/year

   Warm summers, cool winters

   Europe; NE United States;Eastern Canada



Temperate/Deciduous forest

3. **Coniferous forest:**

20-60cm/year

Short growing season, cold winters.

Northern Asia;Northern North America

Coniferous Forest

4. **Tundra**

   25cm/year

   Open; wind swept; dry; ground always frozen

   Far northern Asia; Northern North America

Tundra

Ocean Ecosystems:

- Very large amount of Earth is covered by ocean (~75%)
- 40% of all photosynthesis occurs in oceans.
- 3 types of oceanic ecosystems
- Shallow ocean waters
- Deep ocean water
- Deep ocean surface.
    - Photosynthetic plankton is base of food chain.
    - Only occurs in Deep ocean surface & Shallow ocean ecosystems
    - No photosynthesis can occur in deep ocean because light cannot penetrate deeply into water.

Forest Ecosystem

A forest ecosystem is a terrestrial unit of living organisms (plants, animals and microorganisms), all interacting among themselves and with the environment (soil, climate, water and light) in which they live. The environmental "common denominator" of that forest ecological community is a tree, who most faithfully obeys the ecological cycles of energy, water, carbon and nutrients.

A forest ecosystem has definite boundaries and includes a forest of trees out to the limit of tree growth.

Remember that forests are not the only ecosystems. There are hundreds of thousands of defined and undefined ecosystems that can cover the broadest to the tiniest of areas. An ecosystem can be as small as a pond or a dead tree, or as large as the Earth itself.

Types and Characteristic Features:

(a) Temperate Forest Ecosystem:

The temperate forest ecosystem is very important on Earth. Temperate forests are in regions where the climate changes a lot from summer to winter. Tropical rain forests are in regions where the climate stays constant all year long. Temperate forests are almost always made of two types of trees, deciduous and evergreen. Deciduous trees are trees that lose their leaves in the winter.

Evergreens are trees that keep them all year long, like pine trees. Forests can either be one or the other, or a combination of both. A fourth kind of forest is a temperate rain forest. These are found in California, Oregon and Washington in the United States.

These forests are made of redwoods and sequoias, the tallest trees in the world. The amount of rainfall in an area determines if a forest is present. If there is enough rain to support trees, then a forest will usually develop. Otherwise, the region will become grasslands.

(b) The Tropical Rain Forest Ecosystem:

Tropical rain forests are one of the most important areas on Earth. These special ecosystems are homes to thousands of species animals and plants. Contrary to popular belief, rain forests are not only densely packed plants, but are also full of tall trees that form a ceiling from the Sun above. This ceiling keeps smaller plants from growing. Areas where sunlight can reach the surface are full of interesting plants.

Do you know where rain forests get their name? They are so named because they receive a lot of rain – an average of 80 inches a year. The temperature doesn’t change very much during the year. It is always warm and muggy. The famous Amazon jungle is located in

Brazil, in South America. This particular forest is called the Neotropics. Other large blocks are located in Central and West Africa.

(i) Insects of the Tropical Rain Forest:

The most feared and well known spider in the world resides in the jungle. Tarantulas are one of the creepiest animals you will ever see. Most species of tarantula have poisonous fangs for killing prey and for protection.

Although some are life-threatening to humans, others are harmless. Army ants are just one species of ant in the rain forest. They are called army ants because they march in a long, thick line through the jungle. They only stop when the young larvae reach pupil stage. Once the queen lays its eggs, the ants start marching again.

Beautiful butterflies fill the forest, but at one time these insects weren't so pretty. Butterflies start out as caterpillars, which tend to be a tad on the ugly side. They go through metamorphosis, which is the process of changing into a butterfly. Centipedes aren't so lucky. They don't turn into butterflies, but instead roam the forest looking for food. Some centipedes use poison to kill their prey.

(ii) Tropical Rain Forest Birds:

The birds of the rain forest are the most beautiful in the world. A wide range of colors can be seen darting through the trees as the forest tops come to life. Many species of tropical birds are kept as pets because of their looks.

Hundreds of species of parrot live in the rain forest. The scarlet macaw is just one of these. It is also one of the longest, stretching to a length of 3 feet from its head to the tip of its tail. When these macaws eat a poisonous fruit, they eat a special type of clay that neutralizes the poison.

Toucans are also very interesting birds. They have large beaks that they use to reach fruit they can't get to. Scientists estimate there are 33 species of toucan in the rain forest. Not every tropical bird was blessed with looks. The hoatzin looks more like a peacock without the pretty tail.

Hoatzins are terrible flyers – crash landings are common practice. The brown kiwi is a flightless bird that looks more like a rodent with a long beak and feathers. Kiwis live on the ground instead of the trees. They have special claws used for running, digging and defence.

(iii) Tropical Rain Forest Mammals:

Birds aren't the only creatures that fly through the rain forests. Several species of flying mammals live in the jungle. From the harmless fruit bat to the unique flying squirrel, the tropical rain forests are full of surprises.

The Indian flying fox is one of the largest bats in the world. Its wings can spread out to 5 feet in width. Unlike bats in other parts of the world, these bats do not live in caves. They prefer to .hang in trees during the day. Hundreds or even thousands of bats can be spotted in a single tree.

Vampire bats live in the Amazon jungle in South America. The famous stories of blood-sucking bats probably originated here. These bats do in fact drink the blood of their victims. They usually attack farm animals, but have also enjoyed the blood of humans. But vampire bats only drink a very small amount of fluid.

(iv) Tropical Rain Forest Reptiles:

The tropical rain forests of the world are full of reptiles. Reptiles are cold blooded, which means their body temperature depends on their environment. So, it is important for them to stay in warm climates. Snakes are reptiles, and the rain forests are home to many. The mamba family is the most poisonous of all. They kill their prey by injecting poison with their sharp fangs.

Anacondas make up another snake family. They are some of the longest creatures in the world, as they can reach 30 feet in length. Anacondas prefer to wrap themselves around their prey and squeeze, rather than inject poison. Anacondas swallow their prey whole and sleep while the food is digesting. Chameleons are interesting lizards that can change color.

This enables them to blend in with their surroundings. Not only is this a great disguise from predators, it is also an easy way to sneak up on their prey. Chameleons only eat insects. Geckos are very neat creatures. The flying gecko can glide from tree to tree to escape from predators. Their grip is so strong, that if you tried to pull one off a window, the glass would break before the gecko would let go.

(v) Tropical Rain Forest Primates:

Monkeys and their cousins are all primates. Humans are also primates. There are many species of monkeys in the tropical rain forests of the world. Monkeys can be divided into two groups: new world monkeys and old world monkeys. New world monkeys live only in South and Central America. Spider monkeys live in the rain forests in the Andes Mountains.

They look very strange with their long noses. Spider monkeys eat mostly fruit and nuts, so they are called frugivores. They are joined by the howler monkeys. These primates are so named because they have a special sac that makes their sounds louder.

Old world monkeys live only in Africa and Asia. The colobus monkey is one such kind. These monkeys are called foliovores because they eat leaves. They live in small groups of 15, but other primates live in larger groups of up to 200. There are too many species. Chimpanzees, orangutans and gorillas are all called pongids. These primates are more famous than the others. Gorillas are too big to climb trees, so they are found on the forest floor.

(c) Boreal or Taiga Forests:

The boreal forest ecosystem is the contiguous green belt of conifer and deciduous trees that encircles a large portion of the Northern Hemisphere. In North America, the boreal forest stretches across most of northern Canada and into Alaska. It has long been identified as one of the world's great forest ecosystems.

This forest ecosystem covers roughly 35% of Canada's land mass and is the single largest land based ecosystem in North America. It also contains a significant proportion of Canada's biodiversity and has long been recognized as an important global carbon sink.

Although the boreal is relatively unknown, it is important as the "great lung" of North America, "breathing in" carbon dioxide and "exhaling" oxygen into the atmosphere. In short, the boreal forest manages to do what the rain forest of the Amazon does but with only the fraction of the flora and fauna.

This forest ecosystem houses the largest and smallest mammal species (wood bison & pygmy shrews) of the North American continent. The Boreal forest has many things: great lakes and northern rivers; vast bogs, fens and other organic wetlands. The rich wildlife diversity of the Boreal is a joy to behold: woodland caribou and lynx; whooping cranes and wood bison; northern owls; woodpeckers with three rather than four toes; colorful wood warblers.

The Boreal has more than 5,000 species of conspicuous and colorful fungi, celebrated far more in Scandinavia and Siberia than in North America. Then there are the precious old-growth forests, the richest and most biologically diverse of the Boreal forest communities that are essential for so many Boreal species.

Structure of Forest Ecosystems:

Different organisms exist within the forest layers. These organisms interact with each other and their surroundings. Each organism has a role or niche in sustaining the ecosystem.

Some provide food for other organisms; others provide shelter or control populations through predation:

Producers:

All living organisms' intake energy in order to survive. In a forest ecosystem, trees and other plants get their energy from sunlight. Plants produce their own food, in the form of carbohydrates. Plants are, therefore, called the primary producers, since they produce the basic foodstuffs for other organisms within food chains and food webs. Photosynthesis is the chemical reaction that allows plants to produce their own food.

Consumers:

Animals cannot produce their own food. They must consume food sources for die energy they need to survive. All animals, including mammals, insects, and birds, are called consumers. Consumers rely on plants and other animals as a food source. Details of these animals in a forest ecosystem have been given earlier.

Primary consumers only eat plants and are referred to as herbivores. Secondary consumers are referred to as carnivores and feed on herbivores. Tertiary consumers are carnivores that feed on other carnivores. Omnivores eat both plant and animal matter.

Decomposers:

Leaves, needles, and old branches fall to the forest floor as trees grow. Eventually all plants and animals die. So what happens to all of this plant and animal material? Does it sit on the forest floor forever? Thankfully no. These materials are decomposed by worms, microbes, fungi, ants, and other bugs.

Decomposers break these items down into their smallest primary elements to be used again. Decomposers are important in that they sustain the nutrient cycle of ecosystems.

Humans are part of Forest Ecosystem:

Humans are consumers. We get food and materials from forests. Because of this, we are a part of the forest ecosystem. Human consumption alters forest ecosystems. Human intervention may be necessary to sustain forest communities under the increased pressure of human use.

Sericulture:

Sericulture, or silk farming, is the rearing of silkworms for the production of silk. Although there are several commercial species of silkworms, Bombyx mori is the most widely used and intensively studied silkworm. Silk was first produced in China as early as the Neolithic period

Production

Silkworm larvae are fed with mulberry leaves, and, after the fourth moult, climb a twig placed near them and spin their silken cocoons. This process is achieved by the worm through a dense fluid secreted from its structural glands, resulting in the fiber of the cocoon. The silk is a continuous filament comprising fibroin protein, secreted from two salivary glands in the head of each larva, and a gum called sericin, which cements the filaments. The sericin is removed by placing the cocoons in hot water, which frees the silk filaments and readies them for reeling. This is known as the degumming process.[6] The immersion in hot water also kills the silkworm pupae.

Single filaments are combined to form thread, which is drawn under tension through several guides and wound onto reels. The threads may be plied to form yarn. After drying, the raw silk is packed according to quality.

Stages of production

The stages of production are as follows:

1. The silk moth lays thousands of eggs.
2. The silk moth eggs hatch to form larvae or caterpillars, known as silkworms.
3. The larvae feed on mulberry leaves.
4. Having grown and moulted several times silkworm weaves a net to hold itself
5. It swings its head from side to side in a figure '8' distributing the salivar that will form silk.
6. The silk solidifies when it contacts the air.
7. The silkworm spins approximately one mile of filament and completely encloses itself in a cocoon in about two or three days. The amount of usable quality silk in each cocoon is small. As a result, about 2500 silkworms are required to produce a pound of raw silk)[7]
8. The silk is obtained by brushing the undamaged cocoon to find the outside end of the filament.
9. The silk filaments are then wound on a reel. One cocoon contains approximately 1,000 yards of silk filament. The silk at this stage is known as raw silk. One thread comprises up to 48 individual silk filaments.

Mahatma Gandhi was critical of silk production based on the Ahimsa philosophy "not to hurt any living thing". He also promoted *Ahimsa silk*, wild silk made from the

cocoons of wild and semi-wild silk moths.[8][9][10] In the early 21st century the organisation PETA has campaigned against silk.[11]

-

  Third stage of silkworm

-

  Silkworms on to Modern Rotary montage

-

  silk cocoon in mountages

Silk production in India

India has the unique distinction of being the only country producing all the five known commercial silks, namely, mulberry, tropical tasar, oak tasar, eri and muga, of which muga with its golden yellow glitter is unique and prerogative of India.

Mulberry sericulture is mainly practised in five states namely, Karnataka, Andhra Pradesh, West Bengal, Tamil Nadu and Jammu & Kashmir which jointly account for about 97% of total mulberry silk production in the country.

India is the second largest producer of silk in the world. The silk production has shown a remarkable progress during the year 2013-14. There was an all time increase of 11.8% growth in silk production during 2013-14 when compared to the production during 2012-13. The raw silk production in India during 2013-14 was 26480 MTs which includes 1.9476 MTs of mulberry silk, 2619 MTs of tasar silk, 4237 MTs of eri silk and 148 MTs of muga silk.

During the current financial year (2014-15) it is targeted to produce 28500 MTs silk which includes 3500 MTs of quality bivoltine silk. This also covers production of 2785 MTs of tasar silk, 4760 MTs of eri silk and 150 MTs of muga silk. The focus, at the same time, is also on production of quality bivoltine silk to cater to the requirements of weaving sector. The demand for superior quality bivoltine silk is increasing in India for domestic consumption as well as value added silk products for the export market. The Ministry of Textiles Government of India and Departments of Sericulture in various states provide technical and financial assistance for enhancing the bivoltine silk production.

Policy initiatives recently taken for the development of silk industry

Sericulture is the functional area under the Ministry of Textiles. Some of the recent policy initiatives taken by the ministry to promote sericulture are as follows.

- Sericulture is included as agriculture allied activity under RKVY. This enables the sericulturists to avail the benefits of the scheme for the entire sericulture activities up to reeling.
- The CSB (Amendment) Act, Rules and Regulations have been notified by the Govt. of India to bring quality standards in silkworm seed production.
- Forest Conservation Act has been amended to treat non mulberry sericulture as forest based activity enabling the farmers to undertake Vanya silkworm rearing in the natural host plantation in the forests.

- Increase in basic Custom Duty on silk imports: The Govt. of India during its Budget announcement for 2013-14 has announced increase in the basic custom duty on silk imports from the existing level of 5% to 15% in order to help the silk industry. Earlier during 2011 the Govt. has reduced the custom duty on silk imports from 30% to only 5%, due to which the price of cocoon and raw silk came down drastically. Now the prices have improved and this is seen as a welcome measure for sericulture farmers.
- CDP-MGMREGA convergence guideline have been finalized and issued jointly by the MOT and MORD. These guidelines will help sericulture farmers to avail assistance from MGNREGA scheme.

Forestry and agro-forestry management practices

What is Agroforestry?

AFTA defines agroforestry as an intensive land management system that optimizes the benefits from the biological interactions created when trees and/or shrubs are deliberately combined with crops and/or livestock. There are five basic types of agroforestry practices today in the North America: windbreaks, alley cropping, silvopasture, riparian buffers and forest farming. Within each agroforestry practice, there is a continuum of options available to landowners depending on their own goals (e.g., whether to maximize the production of interplanted crops, animal forage, or trees).

Benefits of Agroforestry

The benefits created by agroforestry practices are both economic and environmental. Agroforestry can increase farm profitability in several ways:

1. the total output per unit area of tree/ crop/livestock combinations is greater than any single component alone
2. crops and livestock protected from the damaging effects of wind are more productive
3. new products add to the financial diversity and flexibility of the farming enterprise.

Agroforestry helps to conserve and protect natural resources by, for example, mitigating non-point source pollution, controlling soil erosion, and creating wildlife habitat. The benefits of agroforestry add up to a substantial improvement of the economic and resource sustainability of agriculture.

Key Traits of Agroforestry Practices

Agroforestry practices are intentional combinations of trees with crops and/or livestock which involve intensive management of the interactions between the components as an integrated agroecosystem. These four key characteristics - intentional, intensive, interactive and integrated - are the essence of agroforestry and are what distinguish it from other farming or forestry practices. To be called agroforestry, a land use practice must satisfy all of the following four criteria:

Intentional: Combinations of trees, crops and/or animals are intentionally designed and managed as a whole unit, rather than as individual elements which may occur in close proximity but are controlled separately.

Intensive: Agroforestry practices are intensively managed to maintain their productive and protective functions, and often involve annual operations such as cultivation, fertilization and irrigation.

Interactive: Agroforestry management seeks to actively manipulate the biological and physical interactions between the tree, crop and animal components. The goal is to enhance the production of more than one harvestable component at a time, while also providing conservation benefits such as non-point source water pollution control or wildlife habitat.

Integrated: The tree, crop and/or animal components are structurally and functionally combined into a single, integrated management unit. Integration may be horizontal or vertical, and above- or below-ground. Such integration utilizes more of the productive capacity of the land and helps to balance economic production with resource conservation.

Education

Research and Development

To advance agroforestry in the North America, research is needed both on basic, process-level questions and on applied management techniques that are appropriate for commercial farm or forest operations. While basic research may, for example, investigate the long-term biological interactions between the components of an agroforestry practice, applied research should seek to maximize the tangible short and intermediate term benefits. Agroforestry practices should be tailored to readily integrate into existing farming or forestry enterprises, minimize the displacement of existing crops, use equipment and technical skills that are readily available, and allow some harvesting of products within conservation agroforestry practices (e.g., hardwood timber from riparian buffer strips). There is the potential to expand the participation of state, community and junior colleges, through their agriculture and forestry programs, in agroforestry research.

The greatest research need is to develop farm-level analyses of the potential economic costs, benefits, and risks associated with agroforestry practices. This information is a vital prerequisite to the objective comparison of both production-and conservation-driven agroforestry practices with alternative land use options. Furthermore, attention should be given to evaluations of future price trends in regional, national and international markets for commodities that can be produced using agroforestry (e.g., hardwood lumber or high-value, wind-sensitive crops). Research on tree-crop-animal-environment interactions should be pursued to provide a scientific basis for optimizing agroforestry designs.

Information and Technology Transfer

Technical information must be developed locally or regionally for application within that region. Information which is too general or which is based on studies conducted in dissimilar regions or climate zones is not likely to convince landowners to adopt agroforestry practices, or provide relevant skills and knowledge to ensure their success. on-farm demonstrations and field days are key to the understanding and appreciation of agroforestry practices by landowners. Education and training in agroforestry are needed both for natural resource professionals and college students.

In addition to the traditional model for the transfer of technology from researcher to extension agent to practitioner, landowners should have greater involvement in all phases of this process. With the assistance of research and extension personnel, local groups of landowners may analyze their own needs for agroforestry development, conduct on-farm experiments under real-life conditions, and then choose the practices most appropriate for their individual properties. Rather than accusing landowners of causing environmental degradation, they

should be approached from a "win-win" perspective. Emphasis should be placed on participatory decision-making including landowner advisory groups. Research and information development should focus on agroforestry practices that afford economic opportunities, increase production efficiency, and provide cost-effective and pro-active solutions to conservation problems.

Landowner Adoption

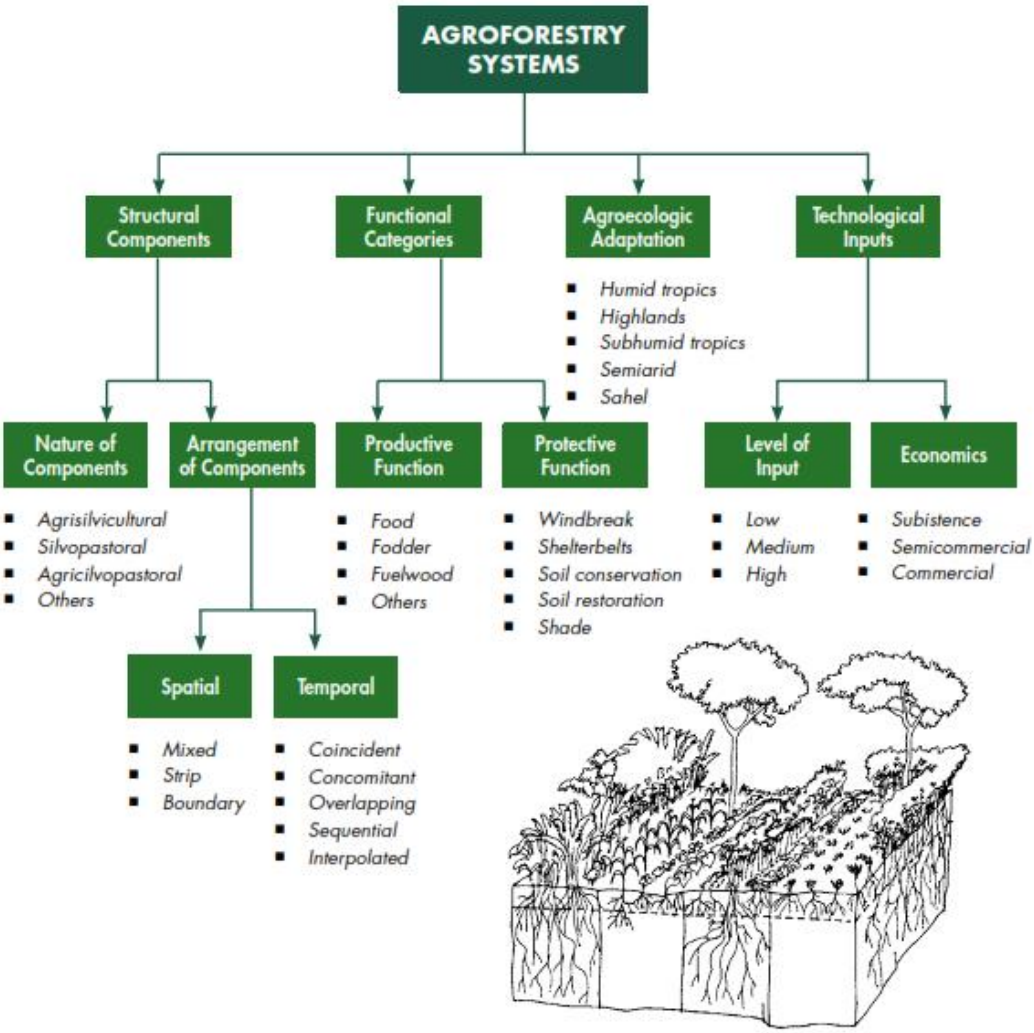
Farmers, ranchers, and foresters may not recognize particular practices as "agroforestry" even though they make use of them (e.g., field windbreaks to protect crops). Agroforestry is a set of practices integrated into larger land use systems. It is not a product or commodity. As a part of integrated land use management systems, agroforestry is relevant to the sustainable production of a wide variety of agricultural commodities, as well as the production of high-value specialty products.

Economic gain is the primary motivating factor in the adoption of agroforestry in the North America. The decision whether or not to adopt an agroforestry practice depends on the decision maker's perception of how that practice compares with alternative land use options. To be acceptable, agroforestry practices must offer:

1. at least as much income potential, without significantly greater risk, compared to other market-driven land uses
2. better prospects for solving a particular conservation problem compared to other practices that do not involve tree planting.

While economics are often paramount in the decision to adopt one land use practice over another, social and aesthetic considerations may also be important to the landowner. The relative weighting of economic, social and other factors will vary among landowners depending on the size of the farming or forestry enterprise, the level of production intensity, proximity to markets, and whether it is a full or part-time activity.

Factors that influence agroforestry development



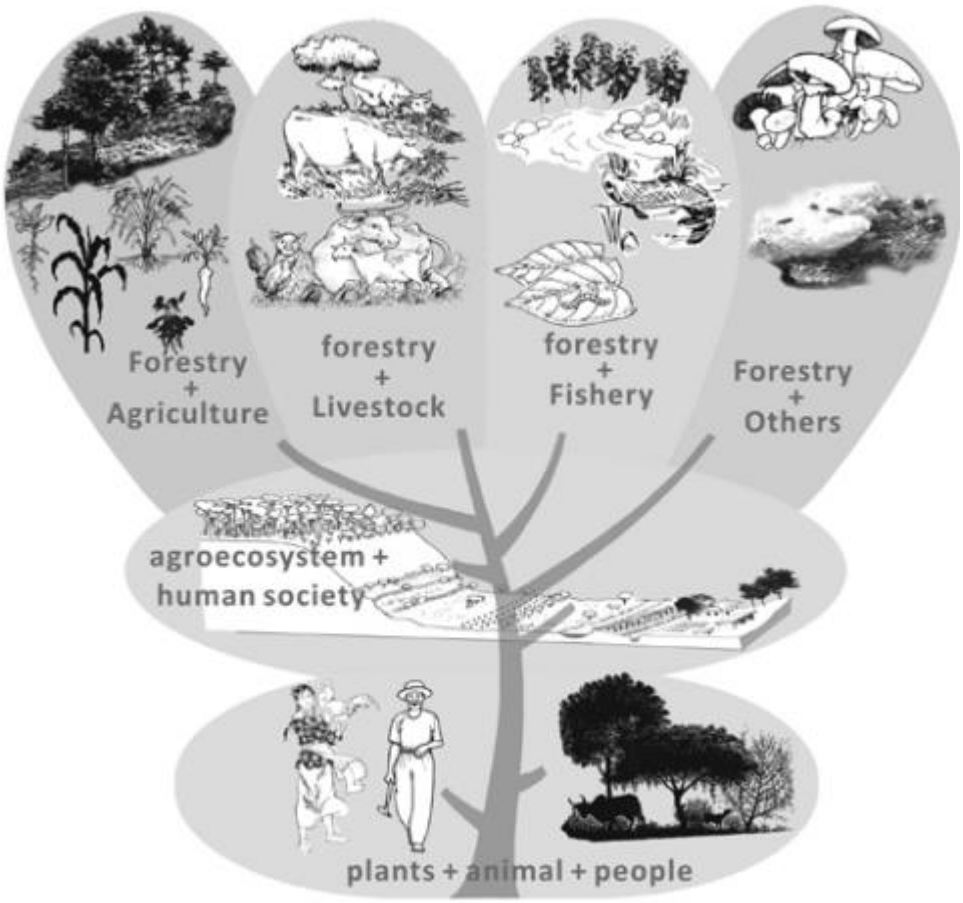
Classification of agroforestry systems

A 'one-model-fits-all' approach does not works for agroforestry because of the diverse biophysical and socioeconomic conditions under which systems can be developed. Factors that influence users' decisions and the selection of particular practices include:

- Government policies and incentives, and rules and regulations, on agriculture and forestry
- The tenure of land, crops and trees, which determine whether it is worthwhile for farmers to plant trees and who benefits
- Technical support and extension services for the supply of inputs (including seed, fertilizer, information on tree management, etc.) and for market delivery (including methods and information on value addition, markets, etc.)
- Access to markets, including distance to different markets, road infrastructure, the ability to undertake sales through cooperatives and the possibility of engaging in barter trade.
- The user group profile, including particular needs from agroforestry (food, cash, medicine, etc.), specific skills and traditional practices, labor availability, the level of education, and peoples' aspirations and expectations
- Biophysical conditions, including climate, soil type, slope, soil and water availability, etc.

Working together between sectors and institutions

As agroforestry represents the integration of forestry and practices including crop production, pastureland management, animal husbandry, fish farming and a range of other agricultural enterprises, multi-agency collaboration is the key to success.



Agroforestry is an integrated dynamic system

Agroforestry production components

Wood lots

i) Sacred wood lots: It is an old traditional practice to conserve and protect an entire forest or a small wood lot in the name of the village Deity (*Kul Daveta*). This is prevalent in every village of the mountainous region of India, particularly so in Himachal Pradesh, Garhwal and Kumaon hills and also Kashmir hills. A temple along with a hut or shelter is constructed to keep the items/utensils of the village Diety. All religious rites are performed in its complex and no body is allowed to fell the trees. This is also a common practice in the hills of Kangra, Mandi and Shimla districts. It is also seen that a perennial water source is managed either in the forest or near it, for common use by the village for drinking purpose.

ii) Private and community wood lots: Community and private forests (wood lots) are protected at the community level. In community forests, the whole area is divided into small block or compartments and each compartment is allotted to the inhabitants for rotational lopping of fodder particularly oaks woodlots during lean (winter) season. Frequent fuel wood collection is permitted only in case of twigs and/or branches which are carried and stocked in a traditional manner (Fig. 3.1a, b & c).

Fig. 3.1a Fire wood collection

Fig. 3.1b Fire wood collection

Villagers employ or engage a caretaker for the protection of private or community forests. No one is allowed to lop and cut trees for fuel wood. If some one is found doing so, the caretaker confiscates his/her sickle/axe and ask him to appear before the village panchayat, which imposes a penalty on him in the form of monetary fine or otherwise. Every household in the village contributes some grain or cash in each crop season for the caretaker's maintenance. In water logged areas along with *kuhal* or *nallas* people raise plantations of *Salix* (Bhains), *Alnus* (Kunish) or other moisture loving trees. Farmers make extensive use of the wood from both private and community forests for building all kinds of houses, shelters etc. (Fig. 3.2a, b

& c) and have devised their own technologies for postharvest processing of the wood (Fig. 3.2d & e).

Fig. 3.1c Stocking of fire wood

Fig 3.2a Traditional roofing made of wood and slates

Fig 3.2b Mountain wooden house

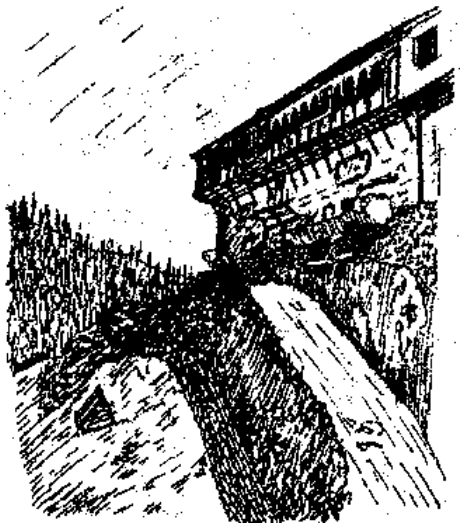
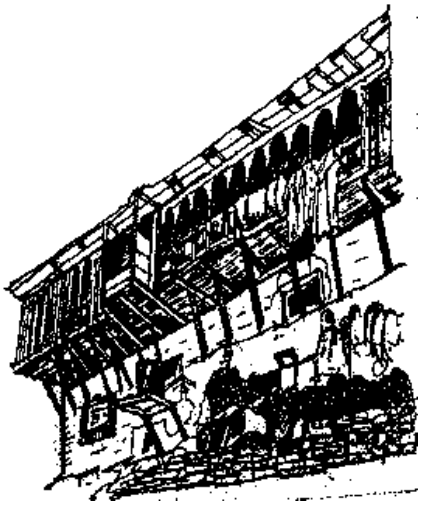


Fig. 3.2c Traditional mountain wood house



Katha extraction

The heart wood chips of *Acacia catechu* trees are boiled in earthen pots along with water for about 12 hours or till the boiling mixture attains a thick syrup like consistency (Fig. 3.3a). This thick liquid is poured into moulds dugout in fine sand which absorbs the tannic acid (liquid) and leaves behind a residue of catchin (Katha) in a crystallized form (Fig. 3.3b). On cooling it solidifies and then is cut into small bricks for sale in the market under the trade name of 'katha'. In India it is consumed with beetle leaves and used medicinally for intestinal disorders and is known to improve digestion.

Fig. 3.2d Timber sawing

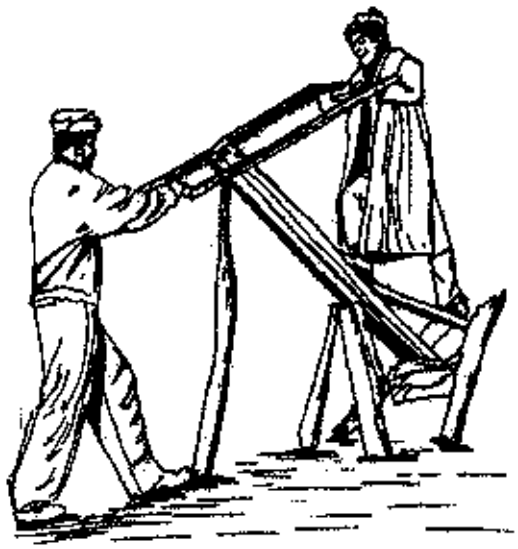


Fig. 3.2e Timber saw

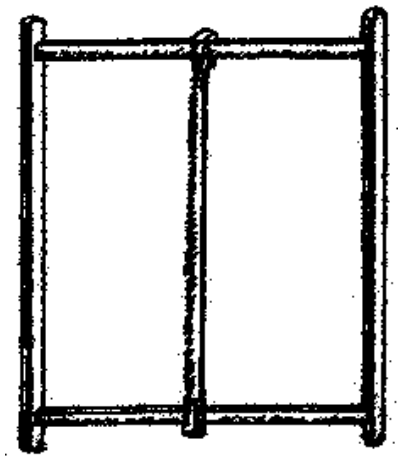


Fig. 3.3a Katha extraction process

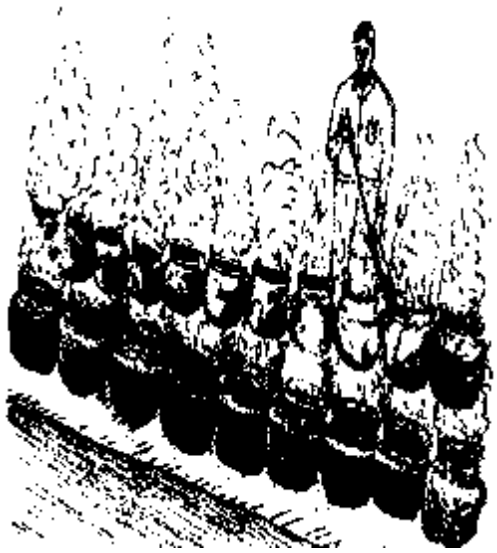


Fig. 3.3b Katha extraction process

Traditional minor forest resources management

In the lower hills of Himachal Pradesh, Uttar Pradesh and of Jammu & Kashmir, *Acacia catechu* (Khair) for katha, *Pinus roxburghii* (chirpine) for resin. *Acacia nilotica* (Kikar) for tannin and gums and *Grewia optiva* (Beul) for fodder and fibre are well known. The villagers manage and protect these trees/wood lots and obtain high economic returns. These wood lots are inaccessible for fuel and timber requirements. The villagers also get seasonal employment in these forests for the collection of value added minor forest products. Similarly in the Kinnaur district of Himachal state, which is known for the production of *Pinus gerardiana* (chilgoza) seeds and *Prunus armenica* (chuli) fruits, the local people have right to collect the same from the forest and to sell them in the market for economic remuneration. The Government forests of these species are managed by the villagers as common properties. These forests are divided into small blocks and each block is allowed to a family for protection, management and collection of produce.

Agri-silviculture

Jhuming or shifting cultivation

It is a widely practiced farming system in the hills of north-east India, locally known as "podu" cultivation. It is believed that this farming system originated in the Neolithic period around 7000 BC.

This system involves cultivation of crops on steep slopes. Land is cleared by cutting forests, bushes etc. upto stump level in December-January, leaving the cut material for drying and then finally burning it to make the land ready for dibbling of seeds of different crops before the onset of rains (Fig. 3.4). The cultivation is confined to the village boundary and the total area brought under cultivation depends upon the family size. After 2-3 years, the area is abandoned for regrowth and a new site is selected to repeat the process.

Shifting cultivation was good at the time when it emerged, because mixed cropping on slopes under rainfed conditions and a dependence on local natural resources only kept disturbance of the soil to a minimum and furthermore its fertility was allowed to replenish adequately. But now, due to increase in both the population and the effective area under this farming system, it is considered to be hazardous because it is leading to resource degradation and ecological imbalance due to deforestation, increase of soil erosion and silting of reservoirs which further lead to floods. It is also a low technology and high labour intensive system.

Fig. 3.4 Forest burning for shifting cultivation

Various research institutes of ICAR, GOI and State Government working in the north-eastern part are recommending at scientifically tempered Agro-horti-silvi pastoral system as an alternative to shifting cultivation. Despite its adverse effects on the eco-system and low productivity it still persists because it is an integral part of the socio-cultural fabric of tribal life in the northeast and is clearly linked with their religious rites and festivals e.g. Agalmaka, Miamua, Rongchugala and Ahia of Garo Hills.

Homestead agroforestry system

A homestead or homegarden is an operational farm unit in which a number of tree species are raised along with livestock, poultry and/or fish; mainly for the purpose of satisfying the farmers' basic needs. This farming is traditional in the Himalayan region. In a home garden multiple crops are present in a multi-tier canopy configuration. The leaf canopies of the components are arranged in such a way that they occupy different vertical layers with the tallest components having foliage tolerant to strong light and high evaporation demand and the shorter components having foliage requiring or tolerating shade and high humidity.

In Hamirpur and Kangra districts of Himachal Pradesh the homestead is constituted of Fodder trees i.e. *Celtis australis* (Khirak), *Bahaunia variegata* (Kachnar), *Grewia optiva* (Beul) in *the* upper story. The middle storey is constituted of bushes like *Adatoda vasica, Vitex negundo,* lemon and Galgal as fruit trees. During the rainy season cucurbits (vines) are grown along with Colocacia, turmeric in the field and (winter) vegetables during the winter season.

In Meghalayan homestead pisciculture is the common practice. Fishes are generally reared in a dugout ponds either in a comer or in the centre of the home garden, so that run off can be collected in it. In the low lying or plain parts paddy is generally grown. Important timber trees are *Pinus kesia* (Khasipine) *Alnus nepalensis* (Utis) *Schima wallichii* (chillowane) etc. are grown in the homestead for their requirement. In the lower storey guava, banana and vegetables are grown for domestic consumption. As per the study conducted by the ICAR Research Complex for NEH Region, Shillong; in a dugout pond of 32m × 15 m 2.2 m size there was a production of 250 kg fishes in one season during the year 1990.

However, wide variations in the intensity of tree cropping are found among homegardens in different locations. This can generally be attributed to the differences in socio-economic conditions of the households and their responses to externally determined changes particularly to price of the inputs and products, dependence on land and tenurial conditions among others.

Plantation crop combination

Plantation crops play a major role in national economics because they generate value added goods for the international market. The important plantation crops of the Himalayan region is tea. Traditionally, tea is grown on waste and marginal lands either in monoculture or in association with indigenous forest tree species. In Himachal Pradesh tea gardens in Kangra Valley are managed under the canopy *of Albizia chinensis* spp. which not only nurse the tea plants by fixing the atmospheric nitrogen in its roots but also provides shade for the development and maintenance of new tenders. The leaf litters *of Albizia* trees also add nutrients to the soil. Similarly in Assam and West Bengal the tree gardens are managed under *Alnus nepalensis* (Utis).

Large cardamom based agroforestry system

Large cardamom (*Amomum subulatum*) a traditional plantation crop is grown in an old typical agroforestry system. It is adapted to humid and shady environment and requires moist soil with good organic content. In natural forests it is raised in association with *Alnus nepalensis* (Utis), a shade tree adjoining to small perennial streams (Thoras). This helps to spread water seepage through the soil during most part of the year. *Alnus nepalensis,* fast growing tree, not only produces fuel wood and timber but also fixes atmosphere nitrogen and enriches the soil by adding litter which in turn benefits the large cardamom. It also serves as a catch crop; attracting leaf feeding insect-pests to itself thereby protecting the large cardamom crop. This silvi-horticultural system is very successfully practiced in Sikkim since over a century. The area reported under large cardamom is about 14, 000 ha in Sikkim and the acreage is expected to increase phenomenally with the aid and assistance of the Cardamom Board established in Sikkim recently. In Joginder Nagar, distt. Mandi (*HP*), cultivation of large cardamom is picking up under *Celtis australis, Ficus* spp., *Alnus* spp. etc. near the perennial streams or *nalahs.*

Bamboo groves as a component of agriculture holdings (Agri-silviculture)

In Sikkim agriculture is well established as compared to other northeastern hill states. The farmer in Sikkim, by and large, adopts a mixed farming system. In all agricultural holdings along the streams and irrigation/drainage channels cultivation of bamboo (*Dendrocalamus hamiltonii* and D. *sikkimensis is* common place (Fig. 3.5a). Bamboo's are extensively used in building small farm houses, goat sheds, piggery enclosures, small baskets and string making (Fig. 3.5b). Large bamboo pipes are used as water conveyers in the farm irrigation/drainage system. Bamboo leaves serve as an excellent winter fodder for goat. Bamboo stumps/culms also protect the water channel from erosion. This system is limited only to he high rainfall areas or where the sufficient water is available to grow bamboo. A similar practice is also found in the Palampur area of Himachal Pradesh as well as in other northeastern states.

Fig. 3.5a Bamboo groves

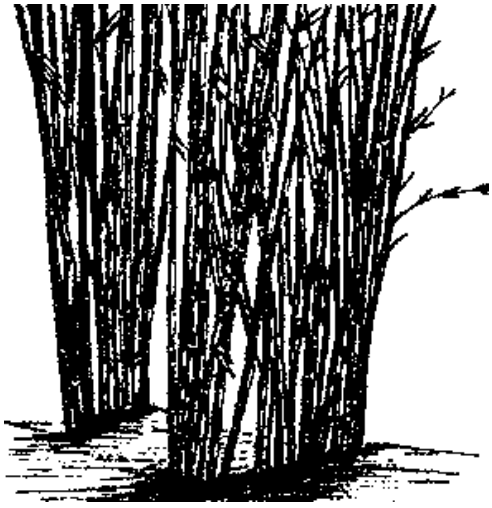
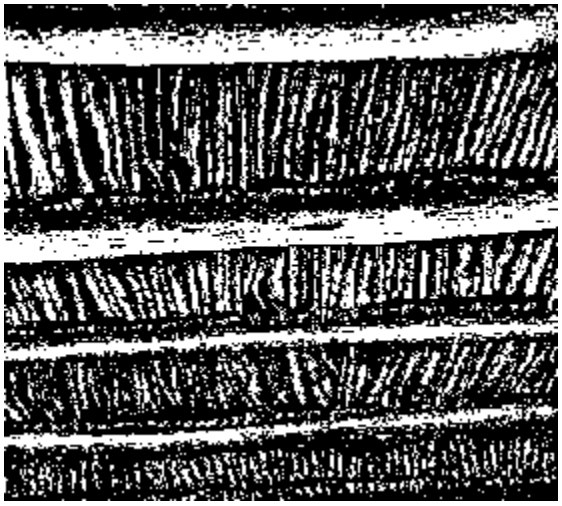


Fig. 3.5b Bamboo house roof

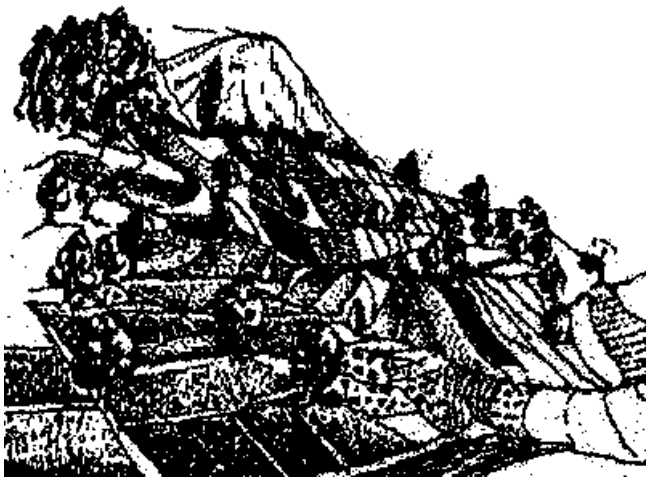


Multipurpose trees on the crop land

It is a common practice in the western Himalayan region to cultivate wheat, peas, potato, cauliflower, mustard etc. during winter and maize, tomato, chillies etc. during the summer season either in monoculture or mixed on the permanent terraces prepared across the hill slopes. Fodder, fuel and timber trees viz. *Grewia optiva* (buel), *Celtis australis* (Khirak),

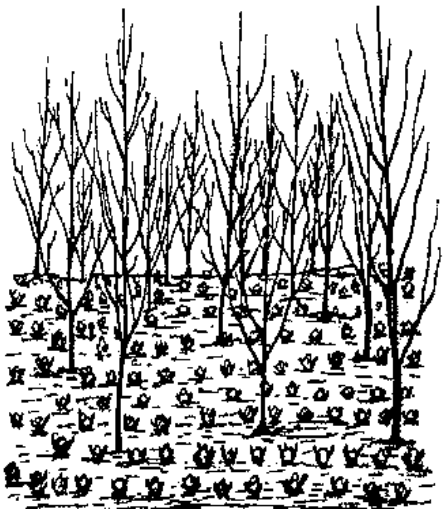
Bauhinia variegata (Kachnar), *Albizzia chinensis* (Ohi), *Toona ciliata* (Toon), *Morus alba* (Toot), *Ulmus laviegata* (meryano), etc. are deliberately left or grown on the bunds of terraces. This type of practice i.e. agrisivicultural system is prevalent in sub-montane and mid hills sub-humid zone of Himachal Pradesh (Fig. 3.6).

Fig. 3.6 Agroforestry: combination of trees and crops



Similarly in the Agri-horticultural system which is predominantly followed in the mid hill-sub humid and high hill-temperate wet zones fruit trees are grown on terrace bunds along with agriculture crops since fuel and fodder are readily available from other sources. Agricultural crops like peas, cabbage, colocacia, turmeric and pulses are generally grown in the inter-spaces of horticultural trees such as *Malus domestica* (apple) *Prunus domestica* (plum), P. *armeniaca* (apricot) P. *persica* (peach), P. *deueis* (almond) and *Pyrus communis* (pear) Fig. 3.7. Tree are uniformly spaced in the field and average density of trees is generally 5 per 100 m^2. In some cases fuel or fodder/timber trees are also retained on the field bunds and managed under agri-horti-silvicultural system. Besides providing fruits/fuelwood/fodder trees grown along bunds also restrict/.check erosion.

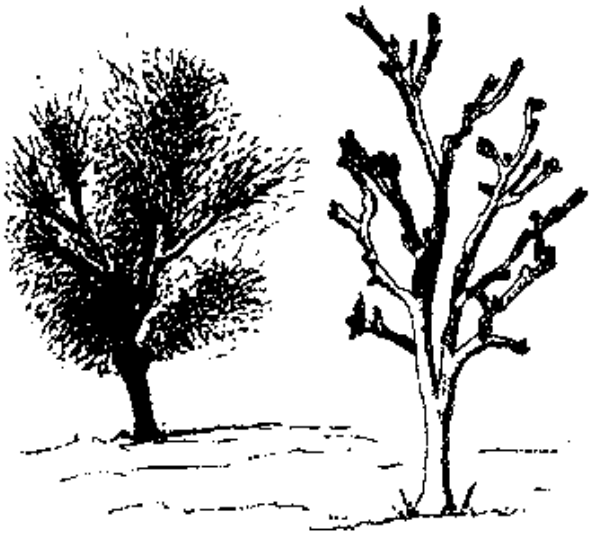
Fig. 3.7 Relay farming in which multi-purpose trees are grown in combination with food crops



Private and community fodder wood blocks

Fodder tree forests in the vicinity of villages, be they on forest land, community land or private land are jointly managed by the managers to meet their fodder need for cattle during lean period i.e. winter season. In the mid and high hills of Himalayas *Quercus* spps. (Oaks) forests are jointly managed and protected for the same whereas in the foot hills or sub-mountainous region other broad leaved trees i.e. *Grewia optiva* (Buel), *Celtis australis* (Khirak), *Bauhinia variegata* (Kachnar), *Albizia chinensis* (Oei) etc. are managed so as to meet fodder and fuel requirements (Fig. 3.8).

Fig. 3.8 Lopped and unlopped tree for fodder and fuel



Seabuckthorn: Potential resource

Seabuckthorn (*Hippophae* L.) an ecologically viable and ethnobotanically sustainable food crop, belonging to family Elaegnaceae, is one of the few potential resources of high mountain areas which has been reported to offer hope to give multiple benefits to poor mountain man (Fig. 3.9a, b & c).

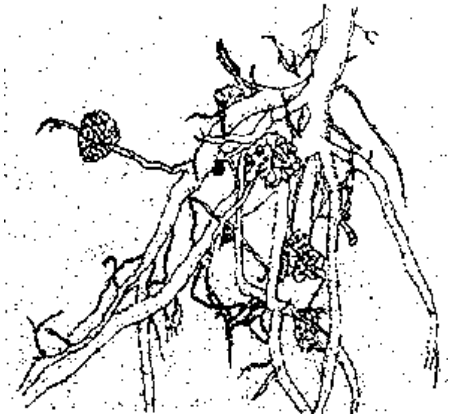
Seabuckthorn, (an indigenous plant which has survived under harsh climatic conditions such as average rainfall 350-1200 mm, average temperature in the range of 10-15°C and sometimes going below -40° to -50°C), is one such specie which has immense potential for satisfying all requirements. Seabuckthorn is widely distributed along high hills, river beds, valleys and along dry mountain slopes of this region both as healthy dense stands as well as in scattered gregarious dense patches in an altitudinal range of 700 in to as high as 5500 m and above.

Fig. 3.9a Seabuckthorn forest

Fig. 3.9b Seabuckthorn fruits

The people in high mountainous areas have been using seabuckthorn fruits for curing several ailments, including skin tumor diseases, digestive disorders and respiratory ailments, foot and mouth disease in cattle, besides using it extensively in agroforestry practices, though the farming community did not know of its exact potential. Seabuckthorn has also been a major source of fuelwood to local inhabitants who face scarcity of other sources of energy. Major traditional uses of Seabuckthorn in high mountainous cold and dry zone of Himachal Pradesh are fuelwood, fodder for goats and cattle (nutritious forage), fencing to protect fruit trees/nurseries/orchards, maintenance of traditional irrigation channel besides soil conservation, improving fertility/quality timber, useful for newly opened areas and subsidiary food items, medicinal products and alcoholic preparations.

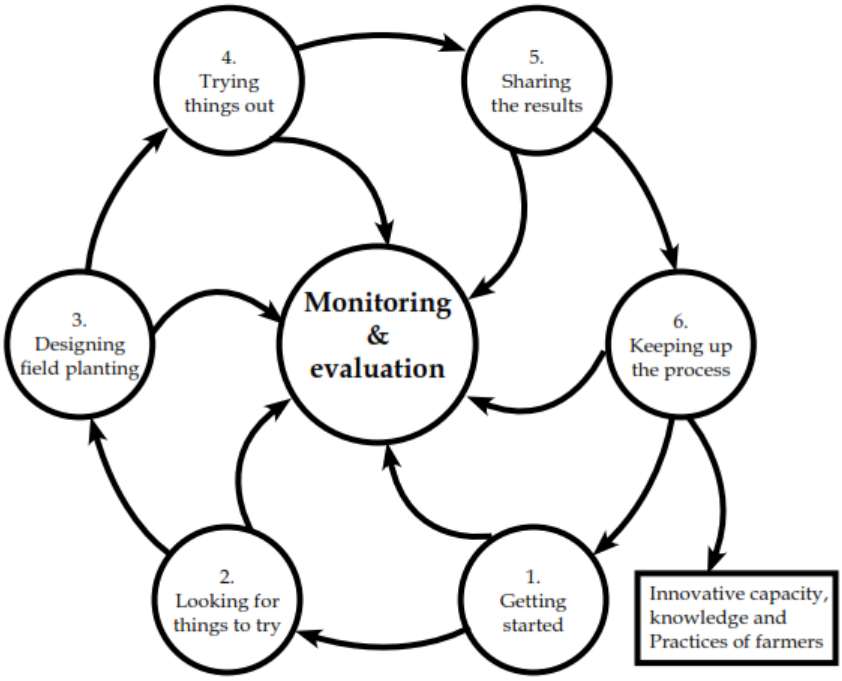
Fig. 3.9c Nitrogen fixing nodules of seabuckthorn



In Himachal Pradesh major gene pool areas have been identified at Spiti valley, Lahaul and Kinnaur, for 4 species and 9 subspecies of genus *Hippophae* reported from different parts of the world.

The introduction, promotion and development of seabuckthorn in this area seems meaningful and will not only help in vegetation rehabilitation, but also in ecological sustenance and economic gains to local farmers of the cold and dry mountain area.

How to design agroforestry practices



Getting started: determining the objectives of planting

This stage involves discussions with all local farmer user groups and other stakeholders on the current situation and the potential ecological, socioeconomic and political consequences of intervention. All stakeholders should agree upon the overall goal and the objectives of intervention. This stage involves the following steps:

- **Organizing farmers into user groups:** usually, ten farmers are organized into one group and each group then selects their own group leader or representative that can work with a project team.
- **Designating the land area for planting:** the user group negotiates with the county forest board for the designation of land (in this particular case, degraded sloping areas) where intervention will take place. Normally, one hectare will be designated to a user group. Soil conditions, road accessibility and water availability are often the principal concerns of user groups.
- **Agreeing management principles:** the basic ecological principles for restoration need to be agreed by and between user groups, for example, the level of tree cover to aim for, the basics of contour farming, and other soil and water conservation measures.

Organizing focus group meeting

Looking for things to try: an assessment of current practices

The project team works with local user groups in a participatory rural appraisal exercise (explained further below) to collect and share information and determine current management practices. The exercise includes inventorying local knowledge, innovations and practices, and listing useful agroforestry species (native and exotic trees, and other species). Methods used in appraisal may include transect walks, mapping of land use and land use change, matrix scoring of species and cultivation practices, and ranking to identify the most promising agroforestry species for planting and the most appropriate management practices to adopt when doing so.

Assessment of local knowledge for agroforestry development

Forestry, biodiversity and poverty reduction

Biodiversity can be described as the diversity of life on Earth. Simply put, biodiversity is the variety of all living things, the places they inhabit, and the interaction between them. Interactions between the components of biodiversity make the Earth inhabitable for all species, including humans. Biodiversity is directly responsible for around 40% of the world's economy, particularly in sectors such as agriculture and forestry, and for providing ecosystem services such as clean water and soil fertility. 70% of the world's poor live in rural areas and depend directly on biodiversity for their survival and well being.

It is estimated that approximately 60 million indigenous people are almost wholly dependent on forests. 350 million people depend on forests for a high degree for subsistence and income, and about 1.2 billion people rely on agroforestry farming systems (World Bank 2004). These people lack the basic necessities to maintain a decent standard of living: sufficient and nutritious food, adequate shelter, access to health services, energy sources, safe drinking -water, education and a healthy environment. In adopting the Millennium Development Goals (MDGs), the countries of the world have set a target of halving global poverty by 2015. Given the importance of forests for the rural poor, it is recognized that forests can be a resource for poverty reduction.

Forest and poverty linkages The convergence of the poor and forests is a result of many factors. Forests tend to be located in remote areas where the reach of the market economy and technological progress are inhibited or slowed. Often, investments by national

governments in rural areas are low. Furthermore, poverty often exists among traditional/indigenous peoples whose dependence on forests is deeply rooted in history and long predates modern social change. Forests are also often a refuge for poor rural people fleeing war. Additionally, forests can be a magnet for the poor where they are open access

Sustainable Forest Management: and Forest Conservation Methods

Sustainable forest management (SFM) is the management of forests according to the principles of sustainable development. Sustainable forest management uses very broad social, economic and environmental goals.

A range of forestry institutions now practice various forms of sustainable forest management and a broad range of methods and tools are available that have been tested over time. The stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems.

The seven thematic areas are:

1. Extent of forest resources

2. Biological diversity

3. Forest health and vitality

4. Productive functions and forest resources

5. Protective functions of forest resources

6. Socio-economic functions

7. Legal, policy and institutional framework

There appears to be growing international consensus on the key elements of sustainable forest management. Seven common thematic areas of sustainable forest management have emerged based on the criteria of the nine ongoing regional and international criteria and indicators initiatives.

Some Forest Conservation Methods:

For the conservation of forests, following steps can be taken:

(a) Conservation of forest is a national problem so it must be tackled with perfect coordination between forest department and other departments.

(b) People's participation in the conservation of forests is of vital importance. So, we must get them involved in this national task.

(c) The cutting of trees in the forests must be stopped at all costs.

(d) Celebrations of all functions, festivals should proceed with tree- plantation.

(e) Cutting of timber and other forest produce should be restricted.

(f) Grasslands should be regenerated.

(g) Forest Conservation Act, 1980 should be strictly implemented to check deforestation.

(h) Joint Forest Management (JFM):

The need to include local communities in forest management has become a growing concern. Local people will only support greening an area if they can see some economic benefits from conservation. An informal agreement between local communities and the forest department began in 1972, in the Midnapore district of West Bengal.

JFM has now evolved into a formal agreement which identifies and respects the local community's right and benefits that they need from forest resources. Under JFM schemes, forest protection communities (FPCs) from local community members are formed. They participate in restoring the green cover and protect the area from being over – exploited.

Realising this, the MoEF formulated the National Forest Policy of 1988 to give added importance to joint forest management (JFM), which co-opts the local village communities and the forest department to work together to sustainable manage our forests.

Another resolution in 1990 provided a formal structure for community participation though the formation of village forest communities (VFS). Based on this experience, new JFM guidelines were issued in 2000 which stipulated that at least 25% of the income from the area must go to community.

From the initiation of the program until 2002, there were 63,618 JFM communities managing over 140,953 sq km of forest under JFM in 27 states in India.

The various states have tried a variety of approaches to JFM. The share of profits for the VFCs ranges from 25% in Kerala to at 100% in Andhra Pradesh, 50% in Gujarat, Maharashtra, Orissa and Tripura. In many states, 25% of the revenue is used for village development.

In many states, non- timber forest products (NTFPS) are available to the people free of cost. Some states have stopped grazing completely. While others have rotational grazing schemes that have helped in forest regeneration.

(i) Agro-forestry:

A sustainable system of managing a piece of land through combined production of agricultural crops and forest crops/ animals, either simultaneously or sequentially to ensure

the most efficient land use under a management system in accordance with socio-cultural practices of local people.

(j) Social Forestry:

It is the plantation in non-forest area for benefit of the society.

Sustainable Vs. Conventional Agriculture

I. Introduction

Farming has enabled human populations to dominate the world's landscapes for many thousands of years. The science of agriculture has been refined and perfected over time to accommodate for the ever-increasing human population. Until recent centuries, productive crops were mostly organic and existed with some permanence as part of a landscape. As communities grow though, less and less land is available for food production and existing crops become easily exhausted. Food insecurity caused by rapid population growth has pressured science to step in and produce many synthetic chemicals and gene manipulation techniques to maximize the potential of plants. In addition, agricultural production has increased tremendously worldwide over the last century. Coupled with this growth however is the pollution and degradation of the natural environment. Many agricultural techniques exist today, but in an effort to adjust to the exponential trends of our population without compromising the integrity of the environment it is necessary to have a global transition towards sustainable farming. With the current population at seven billion and rising, an important question must be addressed: What is the most sustainable and cost effective way to feed the world's population? Fortunately humans have been perfecting agricultural methods for thousands of years, which can help to answer this question.

This paper will analyze and compare two types of farming, organic and conventional. In a comparison of agriculture, my goal is to assess the impact and performance of each practice and then identify the best method for growing crops. Although there are many types of agricultural practices, they can be generalized as sustainable or conventional based on the techniques used. Sustainable / organic farming aims to produce a number of crops, without the use of synthetic chemicals or fertilizers, while enhancing soil composition and promoting biodiversity. This is a traditional, more permanent type of farming that relies on ecosystem services to maintain the integrity of the landscape while still producing sufficient yields. Conventional farming uses synthetic chemicals and fertilizers to maximize the yield of a particular crop or set of crops, which are typically genetically

modified. This method requires a significant amount of chemical and energy input and weakens the ecology of a landscape. In a comparative analysis of these two techniques, it is important to highlight the fact that the crops studied differed in soil composition, geography, and rotation systems. "To carry on extensive long-term trials for a number of crops in several different geographical areas would be of fundamental importance to understand the potential of organic farming as well as to improve farming techniques in general." (Gomiero, Pimentel, and Paoletti 2011). Due to the many different factors determining crop health and productivity, there is a need for much more extensive research on the subject. Therefore, my goal in writing this paper was to use reliable, long-term research that made specific assessments of the two generalized types of farming and then compare the results.

II. History of Agriculture

Agriculture has played a tremendous role in the advancement of human society. Agriculture has been around since roughly 10,000 B.C.E. and has enabled humans to manipulate ecosystems and maximize population growth (*Xtimeline.com*). The science has encouraged people to live and develop rich, permanent settlements all over the world. When humans first discovered the potential of planting seeds, they suddenly had the ability to explore the world and establish infrastructures wherever soils were fertile.

Soon after the start of agriculture people began to select for genes that maximized plant yields. Selective breeding was first implemented on plants over 10,000 years ago to produce desired characteristics in crops (*USDA.gov*). This discovery further contributed to the permanence and size of settlements. With breakthroughs in agriculture, populations increased and development spread.

Early farming techniques depended on local climate conditions, but most farmers would continue to plant on the same field year-after-year until the soils were exhausted of nutrients. This encouraged ingenuities such as crop rotation and intercropping (*Economywatch.com*). Intercropping is a technique in which a variety of crops are grown together, creating a microclimate that favors the survival of each plant, maximizes potential yields and maintains soil fertility (*Archaeology.about.com*). For example, Native Americans developed an intercropping technique over 5,000 years ago called the three sisters, where maize, beans, and squash were grown together (*Archaeology.about.com*). Maize consumes a lot of nitrogen, while beans supply nitrogen to the soil, and squash benefits from a shady, moist climate. Intercropping is one of many early discoveries in agriculture still being implemented today that promotes biodiversity, maintains soil composition, and fortifies plant health.

Techniques such as irrigation, intercropping, and crop rotation have progressively increased efficiency in agriculture. Over the last few centuries however, radical changes have been made in farming and many countries have made a shift toward conventional methods. Factors such as growing populations, economic instability, climate change, and pressures from companies to produce higher yields have contributed to this shift. However, adopting these conventional methods subjects farmers to the greed of industry, as their crops depend on a high input of energy, synthetic chemicals, and genetically modified organisms. And once committed to the conventional practices, farmers find themselves locked in a perpetual cycle of loans, subsidies, and debt.

Conventional Agriculture

Conventional agriculture is a broad term that has a number of definitions, but a crop can be classified as conventional if synthetic chemicals are used to maintain the plants. A significant amount of chemical and energy input is required in conventional agriculture to produce the highest possible yield of crops. "This method usually alters the natural environment, deteriorates soil quality, and eliminates biodiversity." (*USDA.gov*). Conventional agriculture was developed to make farming more efficient, but achieves that efficiency at a major cost to the environment.

The goal of conventional agriculture is to maximize the potential yield of crops. This is achieved through the application of synthetic chemicals, genetically modified organisms, and a number of other industrial products. In maintaining a conventional system, biodiversity, soil fertility, and ecosystems health are compromised (Huntley, Collins, and Swisher). Production of these crops is beneficial to nothing but food security and economy. Once established, a conventional farm requires constant maintenance but produces maximal yields.

Maintenance is made easy for farmers as conventional farming typically involves monocropping, but is also very expensive. In a conventional system farmers will designate entire fields to just one crop, which creates uniformity. Uniformity can determine both the success and failure of conventional systems. A uniform crop is ideal because it reduces labor costs and makes harvesting easy, but it can also impact biodiversity and make crops susceptible to pathogens (Gabriel, Salt, Kunin, and Benton 2013). Chemicals and genetically modified organisms make maintenance of conventional systems relatively simple for farmers, but require a constant input of energy and money. In a conventional system, farmers can apply pesticides and herbicides to crops at a much more efficient rate if they are made up of just one type of plant, but this has a number of unintended consequences. Since the goal of

conventional agriculture is to maximize yields, environmental health and biodiversity are usually not preserved.

IV. Sustainable Agriculture

Where conventional farming represents one extreme of agriculture, sustainable farming represents the other. "Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved." (Gomiero, Pimentel, and Paoletti 2011). Sustainable agriculture is a more holistic approach to farming than conventional in that it relies on ecosystem services and is typically much less detrimental to the surrounding landscape. Sustainable agriculture is a natural way to produce food and has a number of social, economic, and environmental benefits.

There are many types of sustainable farming that all rely on natural cycles to ensure plant health and crop performance. Sustainable farming forgoes the use of synthetic pesticides, herbicides, and fertilizers to produce food. Instead, farmers will plant a variety of plants together to promote biodiversity and ward off pests and pathogens (Nicholls and Altieri 2012). Where conventional systems promote uniformity and depend on synthetic chemicals for protection against disease and pests, sustainable systems rely on biodiversity as a measure to protect against these things.

Sustainable agriculture profits farmers, economies, and food banks while existing symbiotically with the landscape. One example of many in sustainable farming practices, which emphasizes economic benefits and environmental health, is conservation agriculture. "By increasing soil organic matter contents and moisture-holding capacity, CA can double subsistence crop yields in areas where use of fertilizers is uneconomic and it can sustain production in years with low rainfall." (Kassam and Brammer 2013). Conservation agriculture underlines the focus of sustainable agriculture in that it focuses on producing high yields without compromising the integrity of the environment.

V. A Comparison of Agriculture

In a comparison of conventional and sustainable agriculture there should be several points of focus: production, biodiversity, soil composition / erosion, water use, energy use, and greenhouse gas emissions. The environmental impact and production levels of each method will determine its overall viability as a solution to growing trends. It

is necessary to make these comparisons in order to identify the best agricultural method that can sustainably meet the needs of the current population. Although these comparisons are based off of scientific data, there is much more research that needs to be done in order to make a definitive judgment.

To meet the needs of the current population requires a tremendous amount of resources. Not taking into account the environmental damage associated with intense production, conventional agriculture is a feasible way to provide for more people; "… population growth and increasing consumption of calorie- and meat-intensive diets are expected to roughly double human food demand by 2050." (Mueller, Gerber, Johnston, Ray, Ramankutty, and Foley 2012). In addressing this rapid growth, production levels become a serious point of comparison. "Organic yields are globally on average 25% lower than conventional yields according to a recent meta-analysis, although this varies with crop types and species and depends on the comparability of farming systems." (Gabriel, Salt, Kunin, and Benton 2013). Most research indicates that sustainable crops produce much less than conventional systems.

There are many environmental benefits associated with sustainable agriculture, but its production capacity is limited. In general, sustainable agriculture fails to match up to conventional agriculture in terms of production. This result varies though, and in some instances organic crops actually best conventional crops. For example, under drought conditions organic crops tend to produce higher yields because they typically retain more water; "As part of the Rodale Institute Farming System Trial (from 1981 to 2002), Pimentel *et al.*, (2005) found that during 1999, a year of extreme drought, (with total rainfall between April and August of 224 mm, compared with an average of 500 mm) the organic animal system had significantly higher corn yield (1,511 kg per ha) than either organic legume (412 kg per ha) or the conventional (1,100 kg per ha)." (Gomiero, Pimentel, and Paoletti 2011). Although certain conditions may favor organic crops, conventional agriculture is designed to produce the highest yields possible.

Many factors contribute to this difference in production. Conventional crops are designed specifically to produce maximal yields; therefore, the difference should be expected. Typically conventional crops are genetically modified to perform better under certain conditions than sustainable crops (Carpenter 2011). However, these crops are also sprayed with toxic pesticides and herbicides to make up for their uniformity. Some research has been done to determine whether increased biodiversity is related to increased yields; "…farmland biodiversity is typically negatively related to crop yield; generally, organic farming *per se* does not have an effect other than via reducing yields and therefore increasing biodiversity." (Gabriel, Salt, Kunin, and

Benton 2013). Although levels of production are reduced in sustainable agriculture, studies show that higher levels of biodiversity are linked to healthier crops.

Biodiversity plays a large part in this comparison because it is a determinant of agricultural health and performance. The greater the biodiversity, the more immune plants are to pests and disease (Gomiero, Pimentel, and Paoletti 2011). This is important to highlight because conventional agriculture discourages biodiversity and instead relies on synthetic chemicals to maintain crop health. Over 940 million pounds of pesticides are being applied annually with only 10% of that reaching the desired target, a number that could be greatly reduced if conventional agriculture were to implement sustainable alternatives (*Sustainablelafayette.org*). Techniques such as integrated pest management and intercropping could be applied to conventional systems and in turn promote biodiversity.

High biodiversity is important to sustainable farming because it enhances the performance of the ecological cycles that the crops depend upon. Organic agricultural systems are typically much more rich in nutrients and diverse in organisms than conventional systems; "…organic farming is usually associated with a significantly higher level of biological activity, represented by bacteria, fungi, springtails, mites and earthworms, due to its versatile crop rotations, reduced applications of nutrients, and the ban on pesticides." (Gomiero, Pimentel, and Paoletti 2011). It is important to encourage high nutrient levels and biodiversity as these two factors contribute significantly to the health of the crops and the landscape. Although biodiversity does not directly determine crop yield, it does play a major role in the health and permanence of sustainable farms.

Despite the impacts conventional methods have on agricultural land, not all conventional farms degrade biodiversity. In fact, there are many ways farmers can reduce the amount of chemicals and energy they use by implementing low input alternatives; "Overall, the review finds that currently commercialized GM crops have reduced the impacts of agriculture on biodiversity, through enhanced adoption of conservation tillage practices, reduction of insecticide use and use of more environmentally benign herbicides and increasing yields to alleviate pressure to convert additional land into agricultural use." (Carpenter 2011). The global impact agriculture has can be significantly reduced if conventional farmers adopt sustainable techniques.

In addition to higher levels of biodiversity, sustainable farming is typically associated with better soil quality. Organic farms have stronger soil ecology because they promote biodiversity rather than uniformity; "The results confirm that higher levels of total and organic C, total N and soluble organic C are observed in all of the organic

soil." (Wang, Li, and Fan 2012). The increased concentrations of these nutrients can be contributed to the depth of the food web and amount of biomass in sustainable systems. "In a seven-year experiment in Italy, Marinari *et al.* (2006) compared two adjacent farms, one organic and one conventional, and found that the fields under organic management showed significantly better soil nutritional and microbiological conditions; with an increased level of total nitrogen, nitrate and available phosphorus, and an increased microbial biomass content, and enzymatic activities." (Gomiero, Pimentel, and Paoletti 2011). Sustainable crops are more permanent than conventional crops because they work in harmony with the landscape rather than drain it of nutrients and biomass.

Soil management is vital for existing farms because agricultural production is increasing globally and land is becoming less available to accommodate this growth. Conventional systems can improve soil quality by practicing sustainable methods like no-tillage farming, agroforestry, and integrated pest management, but sustainable agriculture is the most effective form of food production in terms of maintaining soil conditions. "Establishing trees on agricultural land can help to mitigate many of the negative impacts of agriculture, for example by regulating soil, water and air quality, supporting biodiversity, reducing inputs by natural regulation of pests and more efficient nutrient cycling, and by modifying local and global climates." (Smith, Pearce, and Wolfe 2012). Again, research shows that an increase in biodiversity and a reduction of chemical input can result in conventional farms with more healthy soils and improved crop performance.

A major problem concerning agriculture is soil erosion caused by nutrient loss, run-off, salinity, and drought. Soil erosion presents a threat to the growth of agriculture because, "Intensive farming exacerbates these phenomena, which are threatening the future sustainability of crop production on a global scale, especially under extreme climatic events such as droughts." (Gomiero, Pimentel, and Paoletti 2011). Organic systems enhance soil composition as well as prevent soil erosion due to the greater amount of plant material and biomass in the soil. Conventional systems manipulate the landscape rather than adapt to it; "…soils under organic management showed <75% soil loss compared to the maximum tolerance value in the region (the maximum rate of soil erosion that can occur without compromising long-term crop productivity or environmental quality -11.2 t ha^{-1} yr^{-1}), while in conventional soil a rate of soil loss three times the maximum tolerance value was recorded." (Gomiero, Pimentel, and Paoletti 2011). Compared to sustainable farming, conventional crops are terribly inefficient at maintaining the integrity of agricultural landscapes. Conventional agriculture is therefore unable meet the demands of the growing populations without consuming a substantial amount of land and non-renewable resources.

On a global scale, water is a renewable resource that can meet the needs of our current population. Locally, however, water is a scarce resource and must be appropriated efficiently. The amount of fresh water available for consumption globally is small, but regional constraints make accessing that water even more difficult for many millions of people. Agriculture accounts for approximately 70% of water use worldwide (*USDA.gov*). Increasing demand for fresh water is pressuring global stocks. To conserve this resource a drastic overhaul of water saving techniques, especially in agriculture, must occur.

Due to the abundance of flora and fauna in sustainable systems, organic soil typically retains much more water than conventional soil. This increased retention rate enables sustainable agricultural systems to produce much higher yields than conventional systems during drought conditions (Gomiero, Pimentel, and Paoletti 2011). This is a desirable characteristic in agricultural land as it allows crops to be more tolerable to changing climate. "In heavy loess soils in a temperate climate in Switzerland water holding capacity was reported being 20 to 40% higher in organically managed soils than in conventional ones… The primary reason for higher yield in organic crops is thought to be due to the higher water-holding capacity of the soils under organic management." (Gomiero, Pimentel, and Paoletti 2011). To manage available water resources, sustainable agriculture is the more efficient approach to feeding the world.

A gap exists between current production rates and potential production rates of crops. Through better management of water and soil, much greater yields can be produced. Increasing efficiency to 100% is not entirely feasible, but implementing sustainable farming techniques would conserve resources and improve crop performance; "Globally, we find that closing yield gaps to 100% of attainable yields could increase worldwide crop production by 45% to 70% for most major crops (with 64%, 71% and 47% increases for maize, wheat and rice, respectively)." (Mueller, Gerber, Johnston, Ray, Ramankutty, and Foley 2012). Meeting future food demands is a dynamic problem that requires consideration of all things, but most importantly water and soil conservation.

Sustainable agriculture relies solely on natural processes for input and recycles nutrients on-site to eliminate the use of non-renewable resources. Alternatively, conventional agriculture requires an incredible amount of energy to produce, prepare, and transport food. Energy efficiency is important to agriculture as it can reduce greenhouse gas emissions and lower costs of production; "Agricultural activities (not including forest conversion) account for approximately 5% of anthropogenic emissions of CO_2 and the 10–12% of total global anthropogenic emissions of GHGs (5.1 to 6.1 Gt CO_2 eq. yr^{-1} in 2005), accounting for nearly all the anthropogenic methane and one to two thirds of all anthropogenic nitrous oxide emissions are due to

agricultural activities." (Gomiero, Pimentel, and Paoletti 2011). Agriculture is responsible for a significant percentage of greenhouse gas emissions, but can also mitigate this impact using sustainable methods. Better management of agricultural land is required to reduce the effects of crop production.

Sustainable agriculture has the ability to offset global greenhouse emissions at a greater rate than conventional agriculture because it is more permanent and does not require much input to produce food. Conventional systems are inefficient at capturing carbon because of soil composition, constant production, and how much energy is being used to maintain the crops. "We use so much machinery, pesticides, irrigation, processing, and transportation that for every calorie that comes to the table, 10 calories or energy have been expended." (*Sustainablelafayette.org*). However, there are measures that can be taken to increase energy efficiency. "This carbon can be stored in soil by SOM and by aboveground biomass through processes such as adopting rotations with cover crops and green manures to increase SOM, agroforestry, and conservation-tillage systems." (Gomiero, Pimentel, and Paoletti 2011). Conventional agriculture operates at a net energy loss, but implementing sustainable practices can reduce costs and benefit the surrounding landscape.

Sustainable agriculture aims to enhance the composition of a landscape while producing sufficient yields. This method is so efficient compared to conventional agriculture because it requires no input of synthetic chemicals or fertilizers, which accounts for a large amount of the greenhouse gas emissions. However, energy efficiency also takes into account the ratio of input to output. In that sense, there is no substantial difference between the two types of agriculture; "…the energy efficiency, calculated as the yield divided by the energy use (MJ ha^{-1}), was generally higher in the organic system than in the conventional system, but the yields were also lower. This meant that conventional crop production had the highest net energy production, whereas organic crop production had the highest energy efficiency." (Gomiero, Pimentel, and Paoletti 2011). Even though conventional systems produce greater yields than sustainable systems, organic crop production is the most energy efficient method.

Studies point toward sustainable agriculture as the best solution to managing the growing population. Although the benefits of sustainable agriculture are abundant, there are several constraints to adopting this method worldwide. Climate conditions vary with geography so where sustainable agriculture is the most efficient system in one part of the world, it may not be entirely feasible in another. "Some authors suggest the adoption of integrated farming, rather than upholding solely organic practices, which they find more harmful than conventional farming, for instance in the case of pest control technologies." (Gomiero, Pimentel, and Paoletti 2011). Many

factors determine the performance of agricultural methods and often the most effective type of agriculture requires a combination of techniques. In addition to local constraints, sustainable agriculture also requires much more labor to maintain crops.

The science of agriculture has allowed human populations to grow exponentially and dominate the world's landscapes. Advancements in this science have enabled humans to manipulate entire ecosystems to cater to their survival. But as populations continue to grow, resources are becoming limited. Water, fuel, and soil are three important factors determining the survival the world's population and it is crucial that they are used as efficiently as possible. In a comparison of sustainable and conventional agriculture, organic farming methods are shown to perform much better for a number of indicators. Sustainable agriculture consumes less water and energy, enhances soil composition, and forgoes synthetic chemical input. Conventional agriculture cannot meet the needs of the current population without compromising the integrity of the environment. Sustainable agriculture has the potential to sequester carbon, feed the world, and enrich the environment. The social, economic, and environmental benefits of this system are reasons why sustainable agriculture is the most viable way to accommodate growing trends.

Methods of conservation of wild life

Conservation of wild life: The conservation of wild life is possible by maintaining essential ecological processes and life supporting systems.

- To preserve the diversity species.
- To ensure sustainable Utilization of species and ecosystems which | support millions of rural communities and major industries.

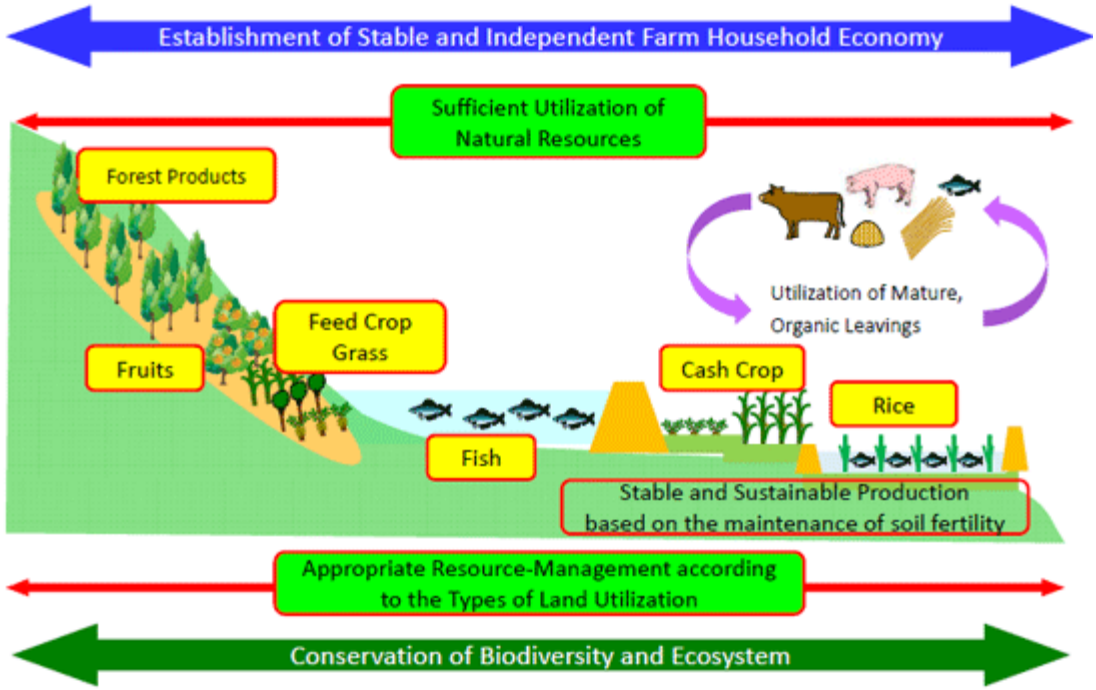
Methods of conservation:

1. Protection by law : Laws should be enacted to protect wild life. The Indian law for wild life conservation came into force in 1972 as the Indian wild life protection Act.
2. Establishment of protected Areas: It is essential to establish wild life sanctuaries, national parks and biosphere reserves to protect wild life. These places provide ideal condition for wild life.
3. Restoration of Original habitat: Restoration of original habitat to be built in the deforested areas. Every year Vanmahostav to be observed.
4. Better living condition: The animals are to be encouraged to live under the cover of thick grass or bushes and trees.
5. Educating common people: Common people to be educated for the conservation and protection of wild life. This is the most effective method of preserving wild life.
6. Training of wild management: Training of wild life forest officers, wild life ecologists is essential for conservation wild life.

Conversation strategy:

The strategies developed by the conservation Biological Diversity (CBD) are as follows:

1. All efforts to be made to conserve threatened species.
2. All endangered species should be protected.
3. The wild life must be protected both in natural habitat and artificial habitats by establishing zoological and botanical gardens or parks.
4. Varieties of useful food crops, plants, animals and microbes should be preserved for national and international breeding programmes.
5. The wild plants and animals should be conserved as a gene bank for the later.
6. The habits of animals should be guarded and well protected.
7. A protected area to be established to preserve the habitat or migratory or wide ranging animal species.
8. Unique ecosystem should be conserved on top priority basis.
9. Ecosystem to be determined for exploited species during productive periods.
10. International trade and commerce to be prohibited in the areas of wild animals and plants.



Types, Importance and Conservation Methods

The term biodiversity was coined as a contraction of biological diversity by E.O. Wilson in 1985. Biodiversity may be defined as the variety and variability of living organisms and the ecological complexes in which they exist. In other words, biodiversity is the occurrence of different types of ecosystems, different species of organisms with the whole range of their variants and genes adapted to different climates, environments along with their interactions and processes.

Biodiversity includes the genetic variability (for which different varieties of spices have appeared in the course of evolution) and diversity of life forms such as plants, animal microbes, etc. living in a wide range of ecosystems.

The diversity may be interspecific (within species) and interspecific (in between the species) but these are well supported by ecosystem. It is seen that the diverse living forms of the ecosystem are modulated with the global environmental changes.

1. Types of Biodiversity:

There are three interrelated hierarchical levels of biodiversity namely, genetic diversity, species diversity and community or ecosystem diversity.

The discussion on each type of diversity is given below:

1. Genetic diversity:

It describes the variation in the number and types of genes as well as chromosomes present in different species. The magnitude of variation in genes of a species increases with increase in size and environmental parameters of the habitat.

The genetic variation arises by gene and chromosome mutation in individuals and in sexually reproducing organisms and it is spread in the population by recombination of genetic materials during cell division after sexual reproduction.

Genetic diversity has the following importance:

(i) It helps in speciation or evolution of new species;

(ii) It is useful in adaptation to changes in environmental conditions;

(iii) It is important for agricultural productivity and development.

2. Species diversity:

It describes the variety in the number and richness of the spices with in a region. The species richness may be defined as the number of species per unit area. The richness of a species tells about the extent of biodiversity of a site and provides a means for comparing different sites.

The species richness depends largely on climatic conditions. The number of individuals of different species with in a region represents species evenness or species equitability. The product species richness and species evenness give

species diversity of a region. When a species is confined entirely to a particular area, it is termed as endemic species.

3. Ecosystem diversity:

It describes the assemblage and Interaction of spices living together and the physical environment a given area. It relates varieties of habitats, biotic communities ecological processes in biosphere. It also tells about the diversity within the ecosystem. It is referred as Land escape diversity because it includes placement and size of various ecosystems.

For example, the landscapes like grass lands, deserts, mountains etc. show ecosystem diversity. The ecosystem diversity is due to diversity of niches, trophic levels and ecological processes like nutrient cycling, food webs, energy flow, role of dominant species and various related biotic interactions. Such type of diversity can generate more productive and stable ecosystems or communities capable of tolerating various types of stresses e.g. drought, flood etc.

According to Whittaker (1965), the community diversities are of three types:

(i) α-Diversity:

It tells the species diversity in a given community.

It depends upon species richness and evenness.

(ii) β-Diversity:

It describes a range of communities due to replacement of species which arises due to the presence of different microhabitats, niches and environmental conditions.

(iii) γ -Diversity:

It describes diversity of habitat over a total land escape or geographical area.

2. Biodiversity of India:

As per available data, the varieties of species living on the earth are 1753739. Out of the above species, 134781 are residing in India although surface area of India is 2% of the earth's surface. Wild life Institute of India has divided it into ten biogeographical regions and twenty five biotic provinces.

Biogeographical regions are:

(i) Trans Himalayas,

(ii) Gangetic plain,

(iii) Desert,

(iv) Semiarid zone;

(v) Western Ghats;

(vi) Deccan peninsula,

(vii) North eastern zone,

(viii) Coastal lands

(ix) Himalayas,

(x) Islands.

India is one of the twelve mega diversity nations of the world due to the following reasons:

(i) It has 7.3% of the global fauna and 10.88% of global flora as per the data collected by Ministry of Environment and forest.

(ii) It has 350 different mammals, 1200 species of birds- 453 different reptiles, 182 amphibians and 45,000 plants spices.

(iii) It has 50,000 known species of insects which include 13,000 butterflies and moths.

(iv) It has 10 different biogeographical regions and 25 biotic provinces having varieties of lands and species.

(v) In addition to geographical distribution, geological events in the land mass provide high level of biological diversity.

(vi) Several crops arose in the country and spread throughout the world.

(vii) There is wide variety of domestic animals like cows, buffaloes, goats, sheep, pigs, horses etc.

(viii) The marine biota includes sea weeds, fishes, crustaceans, molluses, corals, reptiles etc.

(ix) There are a number of hot spots (namely Eastern Ghats, Western Ghats, North Eastern hills etc.).

3. Importance of Biodiversity:

The living organisms on earth are of great diversity, living in diverse habitats and possessing diverse qualities and are vital to human existence providing food, shelter, clothing's, medicines etc.

The biodiversity has the following importance's:

1. Productive values:

Biodiversity produces a number of products harvested from nature and sold in commercial markets. Indirectly it provides economic benefits to people which

include water quality soil protection, equalisation of climate, environmental monitoring, scientific research, recreation etc.

2. Consumptive value:

The consumptive value can be assigned to goods such as fuel woods, leaves, forest products etc. which may be consumed locally and do not figure in national and international market.

3. Social value:

The loss of biodiversity directly influences the social life of the country possibly through influencing ecosystem functions (energy flow and biogeochemical cycle). This be easily understood by observing detrimental effects of global warming and acid rain which cause an unfavorable alteration in logical processes.

4. Aesthetic value:

Aesthetic values such as refreshing fragrance of the flowers, taste of berries, softness of mossed, melodious songs of birds, etc. compel the human beings to preserve them. The earth's natural beauty with its colour and hues, thick forest, and graceful beasts has inspired the human beings from their date of birth to take necessary steps for its maintenance. Similarly botanical and zoological gardens are the means of biodiversity conservation and are of aesthetic values.

5. Legal values:

Since earth is homeland of all living organisms, all have equal right to coexist on the surface of earth with all benefits. Unless some legal value is attached to biodiversity, it will not be possible to protect the rapid extinction of species.

6. Ethical value:

Biodiversity must be seen in the light of holding ethical value. Since man is the most intelligent amongst the living organisms, it should be prime

responsibility and moral obligation of man to preserve and conserve other organisms which will directly or indirectly favour the existence of the man.

7. Ecological value:

Biodiversity holds great ecological value because it is indispensable to maintain the ecological balance. Any disturbance in the delicately fabricated ecological balance maintained by different organisms, will lead to severe problems, which may threaten the survival of human beings.

8. Economic value:

Biodiversity has great economic value because economic development depends upon efficient and economic management of biotic resources.

In the day to day life, human beings are maintaining their lifestyle at the sacrifice of surrounding species which come from diversity of plants and animals struggling for their existence.

So, it is highly essential for the human beings to take care of their surrounding species and make optimum use of their service, for better economic development. Thus, it is rightly told, survival of the man depends upon the survival of the biosphere.

4. Uses of Biodiversity:

Biodiversity has the following uses for the development humanity:

(i) It provides food of all types.

(ii) It provides fibers, sources for the preparation of clothes.

(iii) It provides different types of oil seeds for the preparation of oils.

(iv) It provides new varieties of rice, potato etc. through the process of hybridization.

(v) It provides different drugs and medicines which are based on different plant products.

(vi) It is very essential for natural pest control, maintenance of population of various species, pollination by insects and birds, nutrient cycling, conservation and purification of water, formation of soil etc. All these services together are valued 16.54 trillion dollars per year.

5. Threats to Biodiversity:

Biodiversity is considered as a reservoir of resources to be used for the manufacture of food, medicine, industrial products, etc. But with an increased demand of rapid population growth, biodiversity is gradually depleting. A number of plants" and animal species have already become extinct and many are endangered.

The different factors responsible for causing threat to biodiversity are as follows:

1. Habitat destruction:

The primary cause of loss of biodiversity is habitat loss or destruction which is resulted due to the large industrial and commercial activities associated with agriculture, irrigation, construction of dams, mining, fishing etc.

2. Habitat fragmentation:

With increased population, the habitats are fragmented into pieces by roads, fields, canals, power lines, towns etc. The isolated fragment of habitats restricts the potential of species for dispersal and colonization. In addition, the habitat fragmentation also brings about microclimatic changes in light, temperature, wind etc.

3. Pollution:

The most dreaded factor inducing loss of biodiversity is environmental pollution which include air pollution, Water pollution, industrial pollution, pollution due to chemical Pastes, pesticides radioactive materials etc.

4. Over exploitation:

The natural resources are over exploited to meet growing rural poverty, intensive technological growth and globalization of economy. All these factors together may be responsible for the extinction of a number of species.

5. Introduction of exotic species:

The introduction of exotic species are due to:

(i) horticulture

(ii) agriculture;

(iii) European colonisation and

(iv) accidental transport.

It is seen that some exotic species may kill or eat the native species thereby causing its extinction.

6. Diseases:

Since the animals are more vulnerable to infection, the anthropological activities may increase the incidence of diseases in wild species, leading to their extinction.

7. Shifting or Jhum cultivation:

The shifting or Jhum cultivation by poor tribal people greatly affects the forest structure which is a store house of biodiversity.

8. Poaching of wild life:

A number of wildlife species are becoming extinct due to poaching and hunting.

Table 5.1: Endangered and Endemic Species of India

Category	Enlisted species	Highly endangered Species.
1. Higher plants	15,000	135
2. Mammals	**372**	**69**
3.Reptiles & amphibians	**580**	**22**
4. Birds	**1175**	**40**
5. Fishes	**1693**	**—**

6. Conservation of Biodiversity:

Biodiversity is being depleted by the loss of habitat, fragmentation of habitat, over exploitation of resources, human sponsored ecosystems, climatic changes, pollution invasive exotic spices, diseases, shifting cultivation, poaching of wild life etc.

Since the human beings are enjoying all the benefits from biodiversity, they should take proper care for the preservation of biodiversity in all its form and good health for the future generation i.e., the human being should prevent the degradation and destruction of the habitats thereby maintaining the biodiversity at its optimum level.

Conservation of biodiversity is protection, upliftment and scientific management of biodiversity so as to maintain it at its threshold level and derive sustainable benefits for the present and future generation. In other words, conservation of bio-diversity is the proper management of the biosphere by human beings in such a way that it gives maximum benefits for the present generation and also develops its potential so as to meet the needs of the future generations.

Mainly the conservation of biodiversity has three basic objectives:

(a) To maintain essential ecological processes and life supporting systems.

(b) To preserve the diversity of species.

(c) To make sustainable utilisation of species and ecosystems.

Strategies for Conservation of Biodiversity:

The following strategies should be undertaken in order to conserve biodiversity:

(1) All the possible varieties (old or new) of food, forage and timber plants, live stock, agriculture animals and microbes should be conserved.

(2) All the economically important organisms in protected areas should be identified and conserved.

(3) Critical habitats for each species should be identified and safeguarded.

(4) Priority should be given to preserve unique ecosystems.

(5) There should be sustainable utilisation of resources.

(6) International trade in wild life should be highly regulated.

(7) The poaching and hunting of wildlife should be prevented as far as practicable.

(8) Care should be taken for the development of reserves and protected areas.

(9) Efforts should be made to reduce the level of pollutants in the environment.

(10) Public awareness should be created regarding biodiversity and its importance for the living organisms.

(11) Priority should be given in wildlife conservation programme to endangered species over vulnerable species and to vulnerable species over rare species.

(12) The habitats of migratory birds should be protected by bilateral and multilateral agreement.

(13) The over exploitation of useful products of wild life should be prevented.

(14) The useful animals, plants and their wild relatives should be protected both in their natural habitat (in-situ) and in zoological botanical gardens (ex-situ)

(15) Efforts should be made for setting up of National parks and wild life sanctuaries to safeguard the genetic diversity and their continuing evolution.

(16) Environmental laws should be strictly followed.

Conservation Methods:

There are two types of conservation methods namely in-situ and ex-situ conservations. Let us discuss the different conservation methods along with their importance.

(a) In situ conservation:

The conservation of species in their natural habitat or natural ecosystem is known as in situ conservation. In the process, the natural surrounding or ecosystem is protected and maintained so that all the constituent species (known or unknown) are conserved and benefited. The factors which are detrimental to the existence of species concerned are eliminated by suitable mechanism.

The different advantages of in situ conservation are as follows:

(a) If is a cheap and convenient way of conserving biological diversity.

(b) It offers a way to preserve a large number of organisms simultaneously, known or unknown to us.

(c) The existence in natural ecosystem provides opportunity to the living organisms to adjust to differed' environmental conditions and to evolve in to a better life form.

The only disadvantage of in situ conservation is that it requires large space of earth which is often difficult because of growing demand for space. The protection and management of biodiversity through in situ conservation involve certain specific areas known as protected areas which include national parks, Sanctuaries and Biosphere reserves.

1. Protected areas:

The protected areas are biogeographical areas where biological diversity along with natural and cultural resources are protected, maintained and managed through legal and administrative measures. The demarcation of biodiversity in each area is determined on the basis of climatic and physiological conditions.

In these areas, hunting, firewood collection, timber harvesting etc. are prohibited so that the wild plants and animals can grow and multiply freely without any hindrance. Some protected areas are: Cold desert (Ladakh and Spiti), Hot desert (Thar), Saline Swampy area (Sunderban and Rann of Kutch), Tropical moist deciduous forest (Western Ghats and north East) etc. Protected areas include national parks, sanctuaries and biosphere reserves. There are 37,000 protected areas throughout the world. As per World Conservation Monitoring Centre, India has 581 protected areas, national parks and sanctuaries.

2. National parks:

These are the small reserves meant for the protection of wild life and their natural habitats. These are maintained by government. The area of national parks ranges between 0.04 to 3162 km. The boundaries are well demarcated and circumscribed. The activities like grazing forestry, cultivation and habitat manipulation are not permitted in these areas. There are about 89 national parks in India.

Some important national Parks of India are:

(i) Biological Park, Nandankanan, Orissa,

(ii) Corbett national Park Nainital, U.P. (First national Park)

(iii) Koziranga national Park, Jorhat, Assam

(iv) Tudula national Park, Maharashtra

(v) Hazaribagh national Park, Hazaribagh, Bihar

(vi) Band havgarh national park, M.P.

(vii) Bandipur national park, Karnataka.

(viii) Kanha National Park, M.P.

(ix) Reibul Lamjao National Park, Manipur

(x) Nawgaon National Park, Maharashtra

3. Sanctuaries:

These are the areas where only wild animals (fauna) are present. The activities like harvesting of timbers, collection of forest products, cultivation of lands etc. are permitted as long as these do not interfere with the project. That is, controlled biotic interference is permitted in sanctuaries, which allows visiting

of tourists for recreation. The area under a sanctuary remains in between 0.61 to 7818 km.

Some important sanctuaries of Orissa are as follows:

(i) Nandankanan Zoological Park

(ii) Chandaka Elephant reserve

(iii) Simlipal Tiger Reserve

(iv) Bhitarkanika Wild life Sanctuary

(v) Gharial project at Tikarpada

(vi) Chilika (Nalaban) Sanctuary

4. Biosphere reserves:

Biosphere reserves or natural reserves are multipurpose protected areas with boundaries circumscribed by legislation. The main aim of biosphere reserve is to preserve genetic diversity in representative ecosystems by protecting wild animals, traditional life style of inhabitant and domesticated plant/ animal genetic resources. These are scientifically managed allowing only the tourists to visit.

Some importance of biosphere reserves are as follows:

(a) These help in the restoration of degraded ecosystem.

(b) The main role of these reserves is to preserve genetic resources, species, ecosystems, and habitats without disturbing the habitants.

(c) These maintain cultural, social and ecologically sustainable economic developments.

(d) These support education and research in various ecological aspects,

Some important biosphere reserves are:

Simlipal, (Orissa), Sunderban (West Bengal), Kanha (M.P Kaziranga (Assam) etc. The biosphere reserve net work was introduced by UNESCO 1971.

TABLE 5.2 : BIOSPHERE RESERVES OF INDIA

S. No.	Date notified	Name of the site	Area in sq.km.	Location (state)
1.	0.1.08.86	Nilgiri	5,520	Parts of Wynad, Nagarhole, bandipur and Mudumalai, Nilambur, Silent Valeey, and the Siruvani Hills (Tamil Nadu, Kerala and Karnataka)
2.	18.01.88	Nanda Devi	5,860.69	Parts o the Chamoli, Pithoragarh, and Almorae dis tricts Uttaranchal)
3.	01.09.88	Nokrek	820	Part of Gora Hills (Meghalaya)
4.	14.03.89	Manas	2,837	Parts of the Kokrajhar, Bongaigaon, Parpeta, Nalbari, Kamprup, and Daarang districts (Assam)
5.	29.03.89	Sunderbans	9,630	Parts of the Brahamaputra and Ganga deltas (West Bengal)
6.	18.02.89	Gulf of Mannar	10,500	Indian part of Gulf of Mannar between India and Sri Lanka (Tamil Nadu)
7.	06.01.89	Great Nicobar	885	Southernmost islands of the Andaman and Nicobar islands.
8.	21.06.94	Similpal	4,374	Partof Mayurbhanj district (Orissa)
9.	29.07.97	Dibru-Saikhowa	765	Parts of the Dibrugarh and Tinsukia districts (Assam)
10.	02.09.98	Dehang Debang	5,112	Parts of Siang and Debang Valley (Arunachal Pradesh).
11.	03.03.99	Pachmarhi	4,926.28	Part of the Betul, Hoshangabad, and Chindwara dis tricts (Madhya Pradesh)
12.	07.02.00	Kanchanjanga	2,619.92	Part of Kanchanjanga Hills (Sikkim)

(b) Ex-situ conservation:

Ex-situ conservation involves maintenance and breeding of endangered plants and animals under partially or wholly controlled conditions in specific areas like zoo, gardens, nurseries etc. That is, the conservation of selected plants and animals in selected areas outside their natural habitat is known as ex-situ conservation.

The stresses on living organisms due to competition for food, water, space etc. can be avoided by ex-situ conservation there by providing conditions necessary for a secure life and breeding.

Some important areas under these conservation are:

(i) Seed gene bank,

(ii) Field gene bank;

(iii) Botanical gardens;

(iv) Zoos.

The strategies for ex-situ conservations are:

(i) Identification of species to be conserved.

(ii) Adoption of Different ex-situ methods of conservation.

(i) Long-term captive breeding and propagation for the species which have lost their habitats permanently.

(ii) Short-term propagation and release of the animals in their natural habitat

(iii) Animal translocation

(iv) Animal reintroduction

(v) Advanced technology in the service of endangered species.

The different advantages of ex-situ conservation are:

(a) It gives longer life time and breeding activity to animals.

(b) Genetic techniques can be utilised in the process.

(c) Captivity breed species can again be reintroduced in the wild.

Some disadvantages of this method are:

(a) The favourable conditions may not be maintained always.

(b) Mew life forms cannot evolve.

(c) This technique involves only few species.

Hot Spots:

Hot spots are the areas with high density of biodiversity or mega diversity which are most threatened at present. There are 16 hot spots in world, out of which two are located in India namely North-East Himalayas and Western Ghats.

The hot spots are determined considering four factors:

(i) Degrees of endemism;

(ii) Degree of expectation

(iii) Degrees of threat to habitat due to its degradation and fragmentation and

(iv) Number of Species diversity.

The global hot spot and endemic species present within them are:

(1) North East Himalayas (3,500);

(ii) Western Ghats (1,600);

(iii) Cape region of South Africa (6,000);

(iv) Upland Western Amazonia (5,000);

(v) Madagascar (4,900);

(vi) Philippines (3,700)

(vii) Boreo (3, 500);

(viii) South West Australia (2,830);

(ix) Western Ecuador (2,500);

(x) Colombian Choco (2,500);

(xi) Peninsular Malaysia) (2, 400);

(xii) Californian Floristic Province (2,140);

(xiii) Central Chile (1,450);

(xiv) Eastern Arc. Mts (Tanzania) (535);

(xv) South West Srilanka (500);

(xvi) South west Tvorie (200).

Different mechanisms involved in the conservation of biodiversity is shown in Fig. 5.1.

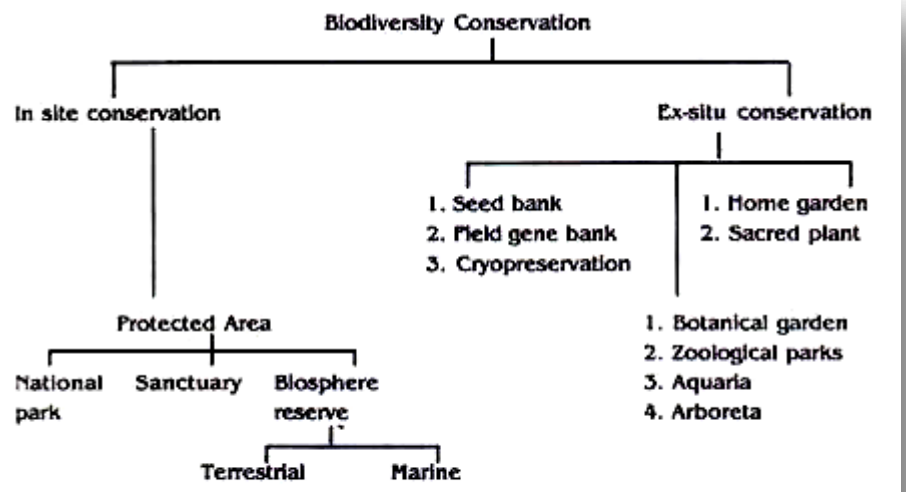


FIG. 5.1 : SCHEME SHOWING BIODIVERSITY CONSERVATION MANAGEMENT SYSTEMS.

THE INDIAN FOREST ACT, 1927

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THE INDIAN FOREST ACT, 1927

(16 of 1927)

[21st September, 1927]

An Act to consolidate the law relating to forests, the transit of forest-produce and the duty leviable on timber and other forest-produce.

Whereas it is expedient to consolidate the law relating to forests, the transit of forest produce and the duty leviable on timber and other forest-produce; It is hereby enacted a follows:

CHAPTER I

PRELIMINARY

1. Short title and extent.(1) This Act may be called the Indian Forest Act, 1921

1[(2) It extends to the whole of India except the territories which, immediately before the 1st November, 1956, were comprised in Part B States.

(3) It applies to the territories which, immediately before the 1st November, 1956, were comprised in the States of Bihar, Bombay, Coorg, Delhi, Madhya Pradesh, Orissa, Punj Uttar Pradesh and West Bengal; but the Government of any State may by notification in Official

Gazette bring this Act into force[2] in the whole or any specified part of that State which this Act extends and where it is not in force.]

2. Interpretation clause. In this Act, unless there is anything repugnant in the subject or context

(1) "cattle" includes elephants, camels, buffaloes, horses, mares, geldings, ponies colts, fillies, mules, asses, pigs, rams, ewes, sheep, lambs, goats and kids;

(2) "Forest-officer" means, any person whom [3] [* * *] the State Government or any office empowered by [3] [* * *] the State Government in this behalf, may appoint to carry out all any of the purposes of this Act or to do anything required by this Act or any rule m thereunder to be done by a Forest-officer;

(3) "forest-offence" means an offence punishable under this Actor under any rule made thereunder;

(4) "forest-produce" includes

(a) the following whether found in, or brought from, a forest or not, that is to say timber, charcoal, caoutchouc, catechu, wood-oil, resin, natural varnish, bark, lac, mahua flowers, mahua seeds,[4][kuth] and myrabolams, and

(b) the following when found in, or brought from a forest, that is to say

(i) trees and leaves, flowers and fruits, and all other parts or produce not herein before mentioned, of trees,

(ii) plants not being trees (including grass, creepers, reeds and moss), and all parts or produce of such plants,

(iii) wild animals and skins, tusks, horns, bones, silk, cocoons, honey and wax, and all other parts or produce of animals, and

(iv) peat, surface soil, rock and minerals (including lime-stone, laterite, mineral oils, and all products of mines or quaries);

[5][(4A) "ownee" includes a Court of Wards in respect of property under the superintendence or charge of such Court;]

(5) "river" includes any stream, canal, creek or other channels, natural or artificial;

(6) "timber" includes trees, when they have fallen or have been felled, and all wood whether cut up or fashioned or hollowed out for any purpose or not; and

(7) "tree" includes palms, bamboos, skumps, brush-wood and canes.

CHAPTER II

OF RESERVED FORESTS

3. Power to reserve forests. The State Government may constitute any forest-land or waste-land which is the property of Government, or over which the Government has proprietary rights, or to the whole or any part of the forest-produce of which the Government is entitled, a reserved forest in the manner hereinafter provided.

4. Notification by State Government.-(1) Whenever it has been decided to constitute any land a reserved forest, the State Government shall issue a notification in the Official Gazette

(a) declaring that it has been decided to constitute such land a reserved forest;

(b) specifying, as nearly as possible, the situation and limits of such land; and

(c) appointing an officer (hereinafter called "the Forest Settlement-officer") to inquire into and determine the existence, nature and extent of any rights alleged to exist in favour of any person in or over any land comprised within such limits or in or over any forest-produce, and to deal with the same as provided in this Chapter.

Explanation. For the purpose of clause (b), it shall be sufficient to describe the limits of the forest by roads, rivers, ridges or other well-known or readily intelligible boundaries.

(2) The officer appointed under clause (c) of sub-section (1) shall ordinarily be a person not holding any forest-office except that of Forest Settlement-officer.

(3) Nothing in this section shall prevent the State Government from appointing any number of officers not exceeding three, not more than one of whom shall be a person holding any forest-office except as aforesaid, to perform the duties of a Forest Settlement-officer under this Act.

5. Bar of accrual of forest-rights. After the issue of a notification under section 4, no right shall be acquired in or over the land comprised in such notification, except by succession or under a grant or contract in writing made or entered into by or on behalf of the Government or some person in whom such right was vested when the notification was issued; and no fresh clearings for cultivation or for any other purpose shall be made in such land except in accordance with such rules as may be made by the State Government in this behalf.

6. Proclamation by Forest Settlement-officer. When a notification has been issued under section 4, the Forest Settlement-officer shall publish in the local vernacular in every town and village in the neighbourhood of the land comprised therein, a proclamation

(a) specifying, as nearly as possible, the situation and limits of the proposed forest;

(b) explaining the consequences which, as hereinafter provided, will ensue on the reservation of such forest; and

(c) fixing a period of not less than three months from the date of such proclamation, and requiring every person claiming any right mentioned in section 4 or section, 5 within such

period either to present to the Forest Settlement-officer a written notice specifying or to appear before him and state, the nature of such right and the amount and particulars of the compensation (if any) claimed in respect thereof.

7. Inquiry by Forest Settlement-officer. The Forest Settlement-officer shall take down in writing all statements made under section 6, and shall at some convenient place inquire into all claims duly preferred under that section, and the existence of any rights mentioned in section 4 or section 5 and not claimed under section 6 so far as the same may be ascertainable from the records of Government and the evidence of any persons likely to be acquainted with the same.

8. Powers of Forest Settlement-officers.-For the purpose of such inquiry, the Forest Settlement-officer may exercise the following powers, that is to say:

(a) power to enter, by himself or any officer authorised by him for the purpose, upon any land, and to survey, demarcate and make a map of the same; and

(b) the powers of a Civil Court in the trial of suits.

9. Extinction of rights.-Rights in respect of which no claim has been preferred under section 6, and of the existence of which no knowledge has been acquired by inquiry under section 7, shall be extinguished, unless before the notification under section 20 is published, the person claiming them satisfies the Forest Settlement-officer that he had sufficient cause for not prefer-ring such claim within the period fixed under section 6.

10. Treatment of claims relating to practice of shifting cultivation. (1) In the case of a claim relating to the practice of shifting cultivation, the Forest Settlement-officer shall record a statement setting forth the particulars of the claim and of any local rule or order under which the practice is allowed or regulated, and submit the statement to the State Government, together with his opinion as to whether the practice should be permitted or prohibited wholly or in part.

(2) On receipt of the statement and opinion, the State Government may make an order permitting or prohibiting the practice wholly or in part.

(3) If such practice is permitted wholly or in part, the Forest Settlement-officer may arrange for its exercise

(a) by altering the limits of the land under settlement so as to exclude land of sufficient extent, of a suitable kind, and in a locality reasonably convenient for the purposes of the claimants, or

(b) by causing certain portions of the land under settlement to be separately demarcated, and giving permission to the claimants to practise shifting cultivation therein under such conditions as he may prescribe.

(4) All arrangements made under sub-section (3) shall be subject to the previous sanction of the State Government.

(5) The practice of shifting cultivation shall in all cases be deemed a privilege subject to control, restriction and abolition by the State Government.

11. Power to acquire land over which right is claimed.(1) In the case of a claim to a right in or over any land, other than a right of way or right of pasture, or a right to forest produce or a water-course, the Forest Settlement-officer shall pass an order admitting or rejecting the same in whole or in part.

(2) If such claim is admitted in whole or in part, the Forest Settlement-officer shall either

(i) exclude such land- from the limits of the proposed forest; or

(ii) come to an agreement with the owner thereof for the surrender of his rights; or

(iii) proceed to acquire such land in the manner provided by the Land Acquisition Act, 1894 (1 of 1894).

(3) For the purpose of so acquiring such land

(a) the Forest Settlement-officer shall be deemed to be a Collector proceeding under the Land Acquisition Act, 1894 (1 of 1894);

(b) the claimant shall be deemed to be a person interested and appearing before him in pursuance of a notice given under section *9* of that Act;

(c) the provisions of the preceding sections of that Act shall be deemed to have been complied with; and

(d) the Collector, with the consent of the claimant, or the Court, with the consent of both parties, may award compensation in land, or partly in land and partly in money.

12. Order on claims to rights of pasture or to forest-produce. In the case of a claim to rights of pasture or to forest-produce, the Forest Settlement-officer shall pass an order admitting or rejecting the same in whole or in part.

13. Record to be made by Forest Settlement-officer. The Forest Settlement officer, when passing any order under section 12, shall record, so far as may be practicable,

(a) the name, fathers name, caste, residence and occupation of the person claiming the right; and

(b) the designation, position and area of all fields or groups fields (if any), and the designation and position of all buildings (if any) in respect of which the exercise of such rights is claimed.

14. Record where he admits claim. If the Forest Settlement-officer admits in whole or in part any claim under section 12, he shall also record the extent to which the claim is so admitted, specifying the number and description of the cattle which the claimant is from time to time entitled to graze in the forest, the season during which such pasture is permitted, the quantity of timber and other forest produce which he is from time to time authorised to take

or receive, and such other particulars as the case may require. He shall also record whether the timber or other forest-produce obtained by the exercise of the rights claimed may be sold or bartered.

15. Exercise of rights admitted.-(1) After making such record the Forest Settlement officer shall, to the best of his ability, having due regard to the maintenance of the reserved forest in respect of which the claim is made, pass such orders as will ensure the continued exercise of the rights so admitted.

(2) For this purpose the Forest Settlement-officer may

(a) set out some other forest-tract of sufficient extent, and in a locality reasonably convenient, for the purposes of such claimants, and record an order conferring upon them a right of pasture or to forest-produce (as the case may be) to the extent so admitted; or

(b) so alter the limits of the proposed forest as to exclude forest-land of sufficient extent, and in a locality reasonably convenient, for the purposes of the claimants; or

(c) record an order, continuing to such claimants a right of pasture or to forest-overpage produce, as the case may be, to the e tent so admitted, at such seasons, within such portions of the proposed forest, and under such rules, as may be made in this behalf by the State Government.

16. Commutation of rights. In case the Forest Settlement-officer finds it impossible having due regard to the maintenance of the reserved forest, to make such settlement under section 15 as shall ensure the continued exercise of the said rights to the extent so admitted, he shall, subject to such rules as the State Government may make in this behalf, commute such rights, by the payment to such persons of a sum of money in lieu thereof, or by the grant of land, or in such other manner as he thinks fit.

17. Appeal from order passed under section 11, section 12, section 15 or section

16. Any person who has made a claim under this Act, or any Forest-officer or other person generally or specially empowered by the State Government in this behalf, may, within three months from the date of the order passed on such claim by the Forest Settlement-officer under section 11, section 12, section 15 or section 16, present an appeal from such order to such officer of the Revenue Department of rank not lower than that of a Collector, as the State Government may, by notification in the Official Gazette, appoint to hear appeals from such orders:

Provided that the State Government may establish a Court (hereinafter called the Forest Court) composed of three persons to be appointed by the State Government, and when the Forest Court has been so established, all such appeals shall be presented to it.

18. Appeal under section 17.(1) Every appeal under section 17 shall be made by petition in writing, and may be delivered to the Forest Settlement-officer, who shall forward it without delay to the authority competent to hear the same.

(2) If the appeal be to an officer appointed under section 17, it shall be heard in the manner prescribed for the time being for the hearing of appeals in matters relating to land-revenue.

(3) If the appeal be to the Forest Court, the Court shall fix a day and a convenient place in the neighbourhood of the proposed forest for hearing the appeal, and shall give notice thereof to the parties, and shall hear such appeal accordingly.

(4) The order passed on the appeal by such officer or Court, or by the majority of the members of such Court, as the case may be, shall, subject only to revision by the State Government, be final.

19. Pleaders. The State Government, or any person who has made a claim under this Act, may appoint any person to appear, plead and act on its or his behalf before the Forest Settlement-officer, or the appellate officer or Court, in the course of any inquiry or appeal under this Act.

20. Notification declaring forest reserved.(1) When the following events have occurred, namely:

(a) the period fixed under section 6 for preferring claims have elapsed and all claims (if any) made under that section or section 9 have been disposed of by the Forest Settlement-officer;

(b) if any such claims have been made, the period limited by section 17 for appealing from the orders passed on such claims has elapsed, and all appeals (if any) presented within such period have been disposed of by the appellate officer or Court; and

(c) all lands (if any) to be included in the proposed forest, which the Forest Settlement-officer has, under section 11, elected to acquire under the Land Acquisition Act, 1894 (1 of 1894), have become vested in the Government under section 16 of that Act,

the State Government shall publish a notification in the Official Gazette, specifying definitely, according to boundary-marks erected or otherwise, the limits of the forest which is to be reserved, and declaring the same to be reserved from a date fixed by the notification.

(2) From the date so fixed such forest shall be deemed to be a reserved forest.

21. Publication of translation of such notification in neighbourhood of forest. The Forest-officer shall, before the date fixed by such notification, cause a translation thereof into the local vernacular to be published in every town and village in the neighbourhood of the forest.

22. Power to revise arrangement made under section 15 or section 18 The State Government may, within five years from the publication of any notification under section 20, revise any arrangement made under section 15 or section 18, and may for this purpose rescind or modify any order made under section 15 or section 18, and direct that any one of the proceedings specified in section 15 be taken in lieu of any other of such proceedings, or that the rights admitted under section 12 be commuted under section 16.

23. No right acquired over reserved forest, except as here provided. No right of any description shall be acquired in or over a reserved forest except by succession or under a grant or contract in writing made by or on behalf of the Government or some person in whom such right was vested when the notification under section 20 was issued.

24. Rights not to be alienated without sanction. (1) Notwithstanding anything contained in section 23, no right continued under clause (c) of sub-section (2) of section 15 shall be alienated by way of grant, sale, lease mortgage or otherwise, without the sanction of the State Government:

Provided that, when any such right is appendant to any land or house, it may be sold or otherwise alienated with such land or house.

(2) No timber or other forest-produce obtained in exercise of any such right shall be sold or bartered except to such extent as may have been admitted in the order recorded under section 14.

25. Power to stop ways and water-courses in reserved forests. The Forest-officer may, with the previous sanction of the State Government or of any officer duly authorised by it in this behalf, stop any public or private way or water-course in a reserved forest, provided that a substitute for the way or water-course so stopped, which the State Government deems to be reasonably convenient, already exists, or has been provided or constructed by the Forest-officer in lieu thereof.

26. Acts prohibited in such forests.(1) Any person who

(a) makes any fresh clearing prohibited by section 5, or

(b) sets fire to a reserved forest, or, in contravention of any rules made by the State Government in this behalf, kindles any fire, or leaves any fire burning, in such manner as to endanger such a forest;

or who, in a reserved forest

(c) kindles, keeps or carries any fire except at such seasons as the Forest-officer may notify in this behalf,

(d) trespasses or pastures cattle, or permits cattle to trespass;

(e) causes any damage by negligence in felling any tree or cutting or dragging any timber;

(f) fells, girdles, lops, or bums any tree or strips off the bark or leaves from, or otherwise damages, the same;

(g) quarries stone, bums lime or charcoal, or collects, subjects to any manufacturing process, or removes, any forest-produce;

(h) clears or breaks up any land for cultivation or any other purpose;

(i) in contravention of any rules made in this behalf by the State Government hunts, shoots, fishes, poisons water or sets traps or snares; or

(j) in any area in which the Elephants Preservation Act, 1879 (6 of 1879), is not in force, kills or catches elephants in contravention of any rules so made,

shall be punishable with imprisonment for a term which may extend to six months, or with fine which may extend to five hundred rupees, or with both, in addition to such compensation for damage done to the forest as the convicting Court may direct to be paid.

(2) Nothing in this section shall be deemed to prohibit

(a) any act done by permission in writing of the Forest-officer, or under any rule made by the state Government; or

(b) the exercise of any right continued under clause (c) of sub-section (2) of section 15, or created by grant or contract in writing made by or on behalf of the Government under section 23.

(3) Whenever fire is caused wilfully or by gross negligence in a reserved forest, the State Government may (notwithstanding that any penalty has been inflicted under this section) direct that in such forest or any portion there of the exercise of all rights of pasture or to forest produce shall be suspended for such period as it thinks fit.

27. Power to declare forest no longer reserved.(1) The State Government may,[6][* * *] by notification in the Official Gazette, direct that, from a date fixed by such notification, any forest or any portion thereof reserved under the Act shall cease to be a reserved forest.

(2) From the date so fixed, such forest or portion shall cease to be reserved; but the rights (if any) which have been extinguished therein shall not revive in consequence of such cessation.

CHAPTER III

OF VILLAGE-FORESTS

28. Formation of village-forests.-(1) The State Government may assign to any village-community the rights of Government to or over any land which has been constituted a reserved forest, and may cancel such assignment. All forests so assigned shall be called village-forests.

(2) The State Government may make rules for regulating the management of village forests, prescribing the conditions under which the community to which any such assignment is made may be provided with timber or other forest-produce or pasture, and their duties for the protection and improvement of such forest.

(3) All the provisions of this Act relating to reserved forests shall (so far as they are not inconsistent with the rules so made) apply to village-forests.

CHAPTER IV

OF PROTECTED FORESTS

29. Protected forests.(1) The State Government may, by notification in the Official Gazette, declare the provisions of this Chapter applicable to any forest-land or waste-land which,, is not included in a reserved forest but which is the property of Government, or over which the

Government has proprietary rights, or to the whole or any part of the forest produce of which the Government is entitled.

(2) The forest-land and waste-lands comprised in any such notification shall be called a "protected forest".

(3) No such notification shall be made unless the nature and extent of the rights of Government and of private persons in or over the forest-land or waste-land comprised therein have been inquired into and recorded at a survey or settlement, or in such other manner as the State Government thinks sufficient. Every such record shall be presumed to be correct until the contrary is proved:

Provided that, if, in the case of any forest-land or waste land, the State Government thinks that such inquiry and record are necessary, but that they will occupy such length of time as in the meantime to endanger the rights of Government, the State Government may, pending such inquiry and record, declare such land to be a protected forest, but so as not to abridge or affect any existing rights of individuals or communities.

30. Power to issue notification reserving trees, etc. The State Government may, by notification in the Official Gazette,

(a) declare any trees or class of trees in a protected forest to be reserved from a date fixed by, the notification;

(b) declare that any portion of such forest specified in the notification shall be closed for such term, rot exceeding thirty years, as the State Government thinks fit, and that the rights of private persons, if any, over such portion shall be suspended during such terms, provided that the remainder of such forest be sufficient, and in a locality reasonably convenient, for the due exercise of the right suspended in the portion so closed; or

(c) prohibit, from a date fixed as aforesaid, the quarrying of stone, or the burning of lime or charcoal, or the collection or subjection to any manufacturing process, or removal of, any forest-produce in any such forest, and the breaking up or clearing for cultivation, for building, for herding cattle or for any other purpose, of any land in any such forest.

31. Publication of translation of such notification in neighbourhood. The Collector shall cause a translation into the local vernacular of every notification issued under section 30 to be affixed in a conspicuous place in every town and village in the neighbourhood of the forest comprised in the notification.

32. Power to make rules for protected forests. The State Government may make rules to regulate the following matters, namely:

(a) the cutting, sawing, conversion and removal of trees and timber, and the collection, manufacture and removal of forest-produce, from protected forests;

(b) the granting of licences to the inhabitants of towns and villages in the vicinity of protected forests to take trees, timber or other forest-produce for their own use, and the production and return of such licences by such persons;

(c) the granting of licences to persons felling or removing trees or timber or other forest-produce from such forests for the purposes of trade, and the production

d) the payments, if any, to be made by the persons mentioned in clauses (b) and (c) for permission to cut such trees, or to collect and remove such timber or other forest-produce;

(e) the other payments, if any, to be made by them in respect of such trees, timber and produce, and the places where such payment shall be made;

(f) the examination of forest-produce passing out of such forests;

(g) the clearing and breaking up of land for cultivation or other purposes in such forests;

(h) the protection from fire of timber lying in such forests and of trees reserved under section 30;

(i) the cutting of grass and pasturing of cattle in such forests;

(j) hunting, shooting, fishing, poisoning water and setting traps or snares in such forests and the killing or catching of elephants in such forests in areas in which the Elephants Preservation Act, 1879 (6 of 1879), is not in force;

(k) the protection and management of any portion of a forest closed under section 30; and

(l) the exercise of rights referred to in section 29.

33. Penalties for acts in contravention of notification under section 30 or of rules under section 32.--(1) Any person who commits any of the following offences, namely:

(a) fells, girdles, lops, taps or bums any tree reserved under section 30, or strips off the bark or leaves from, or otherwise damages, any such tree;

(b) contrary to any prohibition under section 30, quarries any stone, or bums any lime or charcoal or collects, subjects to any manufacturing process, or removes any forest-produce;

(c) contrary to any prohibition under section 30, breaks up or clears for cultivation or any other purpose any land in any protected forest;

(d) sets fire to such forest, or kindles a fire without taking all reasonable precautions to prevent its spreading to any tree reserved under section 30, whether standing fallen or felled, or to say closed portion of such forest;

(e) leaves burning any fire kindled by him in the vicinity of any such tree or closed portion;

(f) fells any tree or drags any timber so as to damage any tree reserved as aforesaid;

(g) permits cattle to damage any such tree;

(h) infringes any rule made under section 32,

shall be punishable with imprisonment for a term which may extend to six months, or with fine which may extend to five hundred rupees, or with both.

(2) Whenever fire is caused wilfully or by gross negligence in a protected forest, the State Government may, notwithstanding that any penalty has been inflicted under this section, direct that in such forest or any portion thereof the exercise of any right of pasture or to forest-produce shall be suspended for such period as it thinks fit.

34. Nothing in this Chapter to prohibit acts done in certain cases. Nothing in this Chapter shall be deemed to prohibit any act done with the permission in writing of the Forest-officer, or in accordance with rules made under section 32, or, except as regards any portion of a forest closed under section 30, or as regards any rights the exercise of which has been suspended under section 33, in the exercise of any right recorded under section 29.

CHAPTER V

OF THE CONTROL OVER FORESTS AND LANDS NOT BEING

THE PROPERTY OF GOVERNMENT

35. Protection of forests for special purposes.-(1) The State Government may, by notification in the Official Gazette, regulate or prohibit in any forest or waste-land

(a) the breaking up or clearing of land for cultivation;

(b) the pasturing of cattle; or

(c) the firing or clearing of the vegetation;

when such regulation or prohibition appears necessary for any of the following purposes:

(i) for protection against storms, winds, rolling stones, floods and avalanches;

(ii) for the preservation of the soil on the ridges and slopes and in the valleys of hilly tracts, the prevention of land slips or of the formation of ravines, and torrents, or the protection of land against erosion, or the deposit thereon of sand, stones or gravel;

(iii) for the maintenance of a water-supply in springs, rivers and tanks;

(iv) for the protection of roads, bridges, railways and other lines of communication;

(v) for the preservation of the public health.

(2) The State Government may, for any such purpose, construct at its own expense, in or upon any forest or waste-land, such work as it thinks fit.

(3) No notification shall be made under sub-section (1) nor shall any work be begun under sub-section (2), until after the issue of a notice to the owner of such forest or land calling on him to show cause, within a reasonable period to be specified in such notice, why such notification should not be made or work constructed, as the case may be, and until his

objections, if any, and any evidence he may produce in support of the same, have been heard by an officer duly appointed in that behalf and have been considered by the State Government.

36. Power to assume management of forests.(1) In case of neglect of, or wilful disobedience to, any regulation or prohibition under section 35, or if the purposes of any work to be-constructed under that section so require, the State Government may, after notice in writing to the owner of such forest or land and after considering his objections, if any, place the same under the control of a Forest-officer, and may declare that all or any of the provisions of this Act relating to reserved forests shall apply to such forest or land.

(2) The net profits, if any, arising from the management of such forest or land shall be paid to the said owner.

37. Expropriation of forests in certain cases.(1) In any case under this Chapter in which the State Government considers that, in lieu of placing the forest or land under the control of a Forest-Officer, the same should be acquired for public purposes, the State 3overnment may proceed to acquire it in the manner provided by the Land Acquisition Act, 1894 (1 of 1894).

(2) The owner of any forest or land comprised in any notification under section 35 may, t any time not less than three or more than twelve years from the date thereof, require that such forest or land shall be acquired for public purposes, and the State Government shall require such forest or land accordingly.

38. Protection of forests at request of owners.(1) The owner of any land or, if there more than one owner thereof, the owners of shares therein amounting in the aggregate at least two-thirds thereof may, with a view to the formation or conservation of forests thereon, represent in writing to the Collector their desire

(a) that such land be managed on their behalf by the Forest-officer as a reserved or a protected forest on such terms as may be mutually agreed upon; or

(b) that all or any of the provisions of this Act be applied to such land.

(2) In either case,-the State Government may, by notification in the Official Gazette, apply to such land such provisions of this Act as it thinks suitable to the circumstances thereof and as may be desired by the applicants.

CHAPTER V1

OF THE DUTY ON TIMBER AND OTHER FOREST-PRODUCE

39. Power to impose duty on timber and other forest-produce.(1) The [7][Central Government] may levy a duty in such manner, at such places and at such rates as it may declare by notification in the Official Gazette on all timber or other forest-produce

(a) which is produced in [8][the territories to which this Act extends], and in respect of which the Government has any right;

(b) which is brought from any place outside [8][the territories to which this Act extends].

[9][* * *]

(2) In every case in which such duty is directed to be levied ad valorem the [7][Central Government] may fix by like notification the value on which such duty shall be assessed.

(3) All duties on timber or other forest-produce which, at the time when this Act comes into force in any territory, are levied therein under the authority of the State Government, shall be deemed to be and to have been duty levied under the provisions of this Act.

[10][(4) Notwithstanding anything in this section, the State Government may, until provision to the contrary is made by [11][Parliament], continue to levy any duty which it was lawfully levying before the commencement[12] of [13][the Constitution], under this section as then in force:

Provided that nothing in this sub-section authorises the levy of any duty which as between timber or other forest-produce of the State and similar produce of the locality outside the State, discriminates in favour of the former, or which, in the case of timber or other forest-produce of localities outside the State, discriminates between timber or other forest-produce of one locality and similar timber or other forest-produce of another locality.]

40. Limit not to apply to purchase-money or royalty.-Nothing in this Chapter shall be deemed to limit the amount, if any, chargeable as purchase-money or royalty on any timber or other forest-produce, although the same is levied on such timber or produce while in transit, in the same manner as duty is levied.

CHAPTER VII

OF THE CONTROL OF TIMBER AND OTHER FOREST-PRODUCE IN TRANSIT

41. Power to make rules to regulate transit of forest produce.--(1) The control of all rivers and their banks as regards the floating of timber, as well as the control of all timber and other forest-produce in transit by land or water, is vested in the State Government, and it may make rules to regulate the transit of all timber and other forest-produce.

(2) In particular and without prejudice to the generality of the foregoing power such rules may

(a) prescribe the routes by which alone timber or other forest-produce may be imported, exported or moved into, from or within [14][the State];

(b) prohibit the import or export or moving of such timber or other produce without a pass from an officer duly authorised to issue the same, or otherwise than in accordance with the conditions of such pass;

(c) provide for the issue, production and return of such passes and for the payment of fees therefor;

(d) provide for the stoppage, reporting, examination and marking of timber or other forest-produce in transit, in respect of which there is reason to believe that any money is payable to

the Government on account of the price thereof, or on account of any duty, fee, royalty or charge due thereon, or, to which it is desirable for the purposes of this Act to affix a mark;

(e) provide for the establishment and regulation of depots to which such timber or other produce shall be taken by those in charge of it for examination, or for the payment of such money, or in order that such marks may be affixed to it, and the conditions under which such timber or other produce shall be brought to, stored at and removed from such depots;

(f) prohibit the closing up or obstructing of the channel or banks of any river used for the transit of timber or other forest-produce, and the throwing of grass, brushwood, branches or leaves into any such river or any act which may cause such river to be closed or obstructed;

(g) provide for the prevention or removal of any obstruction of the channel or banks of any such river, and for recovering the cost of such prevention or removal from the person whose acts or negligence necessitated the same;

(h) prohibit absolutely or subject to conditions, within specified local limits, the establishment of sawpits, the converting, cutting, burning, concealing or making of timber, the altering or effacing of any marks on the same, or the possession or carrying of marking hammers or other implements used for marking timber;

(i) regulate the use of property marks for timber, and the registration of such marks; prescribe the time for which such r6gistration►shall hold good; limit the number of such marks that may be registered by any one person, and provide for the levy of fees for such registration.

(3) The State Government may direct that any rule made under this section shi-11 not apply to any specified class of timber or other forest-produce or to any specified local area.

[15]**[41A. Powers of Central Government as to movements of timber across customs frontiers.**--Notwithstanding anything in section 41, the Central Government may make rules to prescribe the route by which alone timber or other forest-produce may be imported, exported or moved into or from [16][the territories to which this Act extends) across any customs frontier as defined by the Central Government, and any rules made under section 41 shall have effect subject to the rules made under this section.]

42. Penalty for breach of rules made under section 41.-(1) The State Government may by such rules prescribe as penalties for the contravention thereof imprisonment for a term which may extend to six months, or fine which may extend to five hundred rupees, or both.

(2) Such rules may provide that penalties which are double of those mentioned in subsection (1) may be inflicted in cases where the offence is committed after sunset and before sunrise, or after preparation for resistance to lawful authority, or where the offender has been previously convicted of a like offence.

43. Government and Forest-officers not liable for damage to forest-produce at depot.- The Government shall not be responsible for any loss or damage which may occur in respect of any timber or other forest-produce while at a depot established under a rule made under section 41, or while detained elsewhere, for the purposes of this Act; and no Forest-officer shall be responsible for any such loss or damage, unless he causes such loss or damage negligently, maliciously or fraudulently.

44. All persons bound to aid in case of accidents at depot. In case of any accident or emergency involving danger to any property at any such depot, every person employed at such depot, whether by the Government or by any private person, shall render assistance to any Forest-officer or Police-officer demanding his aid in averting such danger or securing such property from damage or loss.

CHAPTER VIII

OF THE COLLECTION OF DRIFT AND STRANDED TIMBER

45. Certain kinds of timber to be deemed property of Government until title thereto proved, and may be collected accordingly.--(1) All timber found adrift, beached, stranded or sunk;

all wood or timber bearing marks which have not been registered in accordance with the rules made under section 41, or on which the marks have been obliterated, altered or defaced by fire or otherwise; and

in such areas as the State Government directs, all unmarked wood and timber,

shall be deemed to be the property of Government, unless and until any person establishes his right and title thereto, as provided in this Chapter.

(2) Such timber may be collected by any Forest-officer or other person entitled to collect the same by virtue of any rule made under section 51 and may be brought to any depot which the Forest-officer may notify as a depot for the reception of drift timber.

(3) The State Government may, by notification in the Official Gazette, 6xempt any class of timber from the provisions of this section.

46. Notice to claimants of drift timber.-Public notice shall from time to time be given by the Forest-officer, of timber collected under section 45. Such notice shall contain a description of the timber, and shall require any person claiming the same to present to such officer, within a period not less than two months from the date of such notice, a written statement of such claim.

47. Procedure on claim preferred to such timber.-(1) When any such-statement is presented as aforesaid, the Forest-officer may, after making such inquiry as he thinks fit, either reject the claim after according his reasons for so doing, or deliver the timber to the claimant.

(2) If such timber is claimed by more than one person, the Forest-officer may either deliver the same to any of such persons who he deems entitled thereto, or may refer the claimants to the Civil Courts, and retain the timber pending the receipt of an order from any such Court for its disposal.

(3) Any person whose claim has been rejected under this section may, within three months from the date of such rejection, institute a suit to recover possession of the timber claimed by him; but no person shall recover any compensation or costs against the Government, or

against any Forest-officer on account of such rejection, or the detention or removal of any timber, or the delivery thereof to any other person under this section.

(4) No such timber shall be subject to process of any Civil, Criminal or Revenue Court until it has been delivered, or a suit has been brought, as provided in this section.

48. Disposal of unclaimed timber.-If no such statement is presented as aforesaid, if the claimant omits to prefer his claim in the manner and within the period fixed by the notice issued under section 46, or on such claim having been so preferred by him and having been rejected, omits to institute a suit to recover possession of such timber within the further period fixed by section 47, the ownership of such timber shall vest in the Government, or, when such timber has been delivered to another person under section 47, in such other person free from all encumbrances not created by him.

49. Government and its officers not liable for damage to such timber.-TN Government shall not be responsible for any loss or damage which may occur in respect any timber collected under section 45, and no Forest-officer shall be responsible for any such loss or damage, unless he causes such loss or damage negligently, maliciously fraudulently,

50. Payments to be made by claimant before timber is delivered to him.-No person shall be entitled to recover possession of any timber collected or delivered as aforesaid until he has paid to the Forest-officer or other person entitled to receive it such sum on account thereof as may be due under any rule made under section 51.

51. Power to make rules and prescribe penalties.-(1) The State Government in make rules to regulate the following matters, namely:

(a) the salving, collection and disposal of all timber mentioned in section 45;

(b) the use and registration of boats used in salving and collecting timber;

(c) the amounts to be paid for salving, collecting, moving, storing or disposing such timber; and

(d) the use and registration of hammers and other instruments to be used marking such timber.

(2) The State Government may prescribe, as penalties for the contravention of any rule made under this section, imprisonment for a term which may extend to six months, or fine which may extend to five hundred rupees, or both.

CHAPTER IX

PENALTIES AND PROCEDURE

52. Seizure of property liable to confiscation.-(1) When there is reason to believe that a forest-offence has been committed in respect of any forest-produce, such produce together with all tools, boats, carts or cattle used in committing any such offence, may be seized by any Forest-officer or Police-officer.

(2) Every officer seizing any property under this section shall place on such property a mark indicating that the same has been so seized, and shall, as soon as may be, make a - report of such seizure to the Magistrate having jurisdiction to try the offence on account which the seizure has been made:

Provided that, when the forest-produce with respect to which such offence is belie to have been committed is the property of Government, and the offender is unknown, it shall be sufficient if the officer makes, as soon as may be, a report of the circumstances to his official superior.

53. Power to release property seized under section 52.-Any Forest-officer of a rank not inferior to that of a Ranger who, or whose subordinate, has seized any tools, boats, carts or cattle under section 52, may release the same on the execution by the owner thereof a bond for the production of the property so released, if and when so required, before the Magistrate having jurisdiction to try the offence on account of which the seizure has been made.

54. Procedure thereupon.-Upon the receipt of any such report, the Magistrate shall, with all convenient despatch, take such measures as may be necessary for the arrest and trial of the offender and the disposal of the property according to law.

55. Forest-produce, tools, etc., when liable to confiscation.--(1) All timber or forest produce which is not the property of Government and in respect of which a forest-offence has been committed, and all tools, boats, carts and cattle used in committing any forest offence, shall be liable to confiscation.

(2) Such confiscation may be in addition to any other punishment prescribed for such offence.

56. Disposal on conclusion of trial for forest-offence, of produce in respect of which it was committed.-When the trial of any forest-offence is concluded, any forest-produce in respect of which such offence has been committed shall, if it is the property of Government or has been confiscated, be taken charge of by a Forest-officer, and, in any other case, may be disposed of in such manner as the Court may direct.

57. Procedure when offender not known or cannot be found.-When the offender is not known or cannot be found, the Magistrate may, if he finds that an offence has been committed, order the property in respect of which the offence has been committed to be confiscated and taken charge of by the Forest-officer, or to be made over to the person whom the Magistrate deems to be entitled to the same:

Provided that no such order shall be made until the expiration of one month from d date of seizing such property, or without hearing the person, if any, claiming any rig thereto, and the evidence, if any, which he may produce in support of his claim.

58. Procedure as to perishable property siezed under section 52.-The Magistrate may, notwithstanding anything hereinbefore contained, direct the sale of any property seized under section 52 and subject to speedy and natural decay, and may deal with the proceeds as he would have dealt with such property if it had not been sold.

59. Appeal from orders under section 55, section 56 or section 57.-The officer made the seizure under section 52, or any of his official superiors, or any person claim to be interested in the property so seized, may, within one month from the date of any order passed under section 55, section 56 or section 57, appeal therefrom to the Court to will orders made by such Magistrate are ordinarily appealable, and the order passed on A appeal shall be final.

60. Property when to vest in Government.-When an order for the confiscation any property has been passed under section 55 or section 57, as the case may be, and the period limited by section 59 for an appeal from such order has elapsed, and no such an apppeal has been preferred, or when, on such an appeal being preferred, the Appellate C4 confirms such order in respect of the whole or a portion of such property, such property or such portion thereof, as the case may be, shall vest in the Government free from all incumbrances.

61. Saving of power to release property seized.-Nothing hereinbefore contained shall be deemed to prevent any officer empowered in this behalf by the State Government, from directing at any time the immediate release of any property seized under section 52.

62. Punishment for wrongful seizure.-Any Forest-officer or Police-officer who vexatiously and unnecessarily seizes any property on pretence of seizing property liable confiscation under this Act shall be punishable with imprisonment for a term which extend to six months, or with fine which may extend to five hundred rupees, or with both.

63. Penalty for counterfeiting or defacing marks on trees and timber and for altering boundary marks.-Whoever, with intent to cause damage or injury to the public or to any person, or to cause wrongful gain as defined in the Indian Penal Code

(a) knowingly counterfeits upon any timber or standing tree a mark used by Forest-officers to indicate that such timber or tree is the property o Government or of some person, or that it may lawfully be cut or removed some person; or

(b) alters, defaces or obliterates any such mark placed on a tree or on timber by under the authority of a Forest-officer; or

(c) alters, moves, destroys or defaces any boundary-mark of any forest or waste land to which the provisions of this Act are applied,

shall be punishable with imprisonment for a term which may extend to two years, or fine, or with both.

64. Power to arrest without warrant.--(1) Any Forest-officer or Police-officer without orders from a Magistrate and without a warrant, arrest any person against whom a reasonable suspicion exists of his having been concerned in any forest-offence punishable with imprisonment for one month or upwards.

(2) Every officer making an arrest under this section shall, without unnecessary delay and subject to the provisions of this Act as to release on bond, take or send the person arrested before the Magistrate having jurisdiction in the case, or to the officer in charge of the nearest police station.

(3) Nothing in this section shall be deemed to authorise such arrest for any act which is an offence under Chapter IV unless such act has been prohibited under clause (c) of section 30.

65. Power to release on a bond a person arrested.-Any Forest-officer of a rank not inferior to that of a Ranger, who, or whose subordinate, has arrested any person under the provisions of section 64, may release such person on his executing a bond to appear, if and when so required, before the Magistrate having jurisdiction in the case, or before the officer in charge of the nearest police station.

66. Power to prevent commission of offence.-Every Forest-officer and Police officer shall prevent, and may interfere for the purpose of preventing, the commission of any forest-offence.

67. Power to try offences summarily.-The District Magistrate or any Magistrate of the first class specially empowered in this behalf by the State Government may try summarily, under the Code of Criminal Procedure, 1898, any forest-offence punishable with imprisonment for a term not exceeding six months, or fine not exceeding five hundred rupees, or both.

68. Power to compound offences.-(1) The State Government may, by notification in the Official Gazette, empower a Forest officer

(a) to accept from any person against whom a reasonable suspicion exists that he has committed any forest-offence, other than an offence specified in section 62 or section 63, a sum of money by way of compensation for the offence which such person is suspected to have committed, and

(b) when any property has been seized as liable to confiscation, to release the same on payment of the value thereof as estimated by such officer.

(2) On the payment of such sum of money, or such value, or both, as the case may be, to such officer, the suspected person, if in custody, shall be discharged, the property, if any seized shall be released, and no further proceedings shall be taken against such person or property.

(3) A Forest-officer shall not be empowered under this section unless he is a Forest officer of a rank not inferior to that of a Ranger and is in receipt of a monthly salary amounting to at least one hundred rupees, and the sum of money accepted as compensation under clause (a) of sub-section (1) shall in no case exceed the sum of fifty rupees.

69. Presumption that forest-produce belongs to Government.-When in any proceedings taken under this Act, or in consequence of anything done under this Act, a question arises as to whether any forest-produce is the property of the Government, such produce shall be presumed to be the property of the Government until the contrary is proved.

CHAPTER X

CATTLE-TRESPASS

70. Cattle-trespass Act, 1871, to apply.-Cattle trespassing in a reserved forest any portion of a protected forest which has been lawfully closed to grazing shall be deem to be cattle doing

damages to a public plantation within the meaning of section II of Cattle-trespass Act, 1871 (1 of 1871), and may be seized and impounded as such by Forest-officer or Police-officer.

71. Power to alter fines fixed under that Act.-The State Government may, notification in the Official Gazette, direct that, in lieu of the fines fixed under section I the Cattle-trespass Act, 1871 (1 of 1871), there shall be levied for each head of cattle impounded under section 70 of this Act such fines as it thinks fit, but not exceeding following, that is to say:-

For each elephant ten rupees

For each buffalo or camel two rupees

For each horse, mare, gelding, pony, colt, filly, mule, bull,

bullock, cow, or heifer one rupee

For each calf, ass, pig, ram, ewe, sheep, lamb, goat or kid eight annas

CHAPTER XI

OF FOREST-OFFICERS

72. State Government may invest Forest-officers with certain powers.-(1) The State Government may invest any Forest-officer with all or of the following powers, that is to say:-

(a) power to enter upon any land and to survey, demarcate and make a map of the same;

(b) the powers of a Civil Court to compel the attendance of witnesses and production of documents and material objects;

(c) power to issue a search-warrant under the Code of Criminal Procedure, 1898 (5 of 1898); and

(d) power to hold an inquiry into forest-offences, and, in the course of such inquiry, to receive and record evidence.

(2) Any evidence recorded under clause (d) of sub-section (1) shall be admissible in subsequent trial before a Magistrate, provided that it has been taken in the presence of accused person.

73. Forest officers deemed public servants.-All Forest-officers shall be deemed be public servants within the meaning of the Indian Penal Code, 1860 (45 of 1860).

74. Indemnity for acts done in good faith.-No suit shall lie against any public servant for anything done by him in good faith under this Act.

75. Forest-officers not to trade.-Except with the permission in writing of the State Government, no Forest-officer shall, as principal or agent, trade in timber or other forest produce, or be or become interested in any lease of any forest or in any contract for working any forest, whether in or outside [17][the territories to which this Act extends].

CHAP TER XII

SUBSIDIARY RULES

76. Additional powers to make rules.-The State Government may make rules

(a) to prescribe and limit the powers and duties of any Forest-officer under this Act;

(b) to regulate the rewards to be paid to officers and informers out of the proceeds of fines and confiscation under this Act;

(c) for the preservation, reproduction and disposal of trees and timber belonging to Government, but grown on lands belonging to or in the occupation of private persons; and

(d) generally, to carry out the provisions of this Act.

77. Penalties for breach of rules.-Any person contravening any rule under this Act, for the contravention of which no special penalty is provided, shall be punishable with imprisonment for a term which may extend to one month, or fine which may extend to five hundred rupees, or both.

78. Rules when to have force of law.-All rules made by the State Government under this Act shall be published in the Official Gazette, and shall thereupon, so far as they are consistent with this Act, have effect as if enacted therein.

CHAPTER XIII

MISCELLANEOUS

79. Persons bound to assist Forest-officers and Police-officers.-(1) Every person who exercises any right in a reserved or protected forest, or who is permitted to take any forest-produce from, or to cut and remove timber or to pasture cattle in, such forest, and every person who is employed by any such person in such forest, and

every person in any village contiguous to such forest who is employed by the Government or who receives emoluments from the Government for services to be performed to the community,

shall be bound to furnish without unnecessary delay to the nearest Forest-officer or Police officer any information he may possess respecting the commission of, or intention to commit, any forest-offence, and shall forthwith take steps, whether so required by any Forest-officer or Police officer or not,-

(a) to extinguish any forest fire in such forest of which he has knowledge or information;

(b) to prevent by any lawful means in his power any fire in the vicinity of such forest of which he has knowledge or information from spreading to such forest,

and shall assist any Forest-officer or Police-officer demanding his aid

(c) in preventing the commission in such forest of any forest-offence; and

(d) when there is reason to believe that any such offence has been committed such forest in discovering and arresting the offender.

(2) Any person who, being bound so to do, without lawful excuse (the burden ofprovin which shall lie upon such person) fails

(a) to furnish without unnecessary delay to the nearest Forest-officer or Polic(officer any information required by sub-section (1);

(b) to take steps, as required by sub-section (1), to extinguish any forest fire in reserved or protected forest;

(c) to prevent, as required by sub-section (1), any fire in the vicinity of such fore.4 from spreading to such forest or

(d) to assist any Forest-officer or Police officer demanding his aid in preventing th commission in such forest of any forest-offence, or, when there is reason believe that any such offence has been committed in such forest, in discover and arresting the offender,

shall be punishable with imprisonment for a term which extend to one month, or with fine which may extend to two hundred rupees, or with both.

80. Management of forests the joint property of Government and other persons.(1) If the Government and any person be jointly interested in any forest or waste-land, a in the whole or any part of the produce thereof, the State Government may either

(a) undertake the management of such forest, waste-land or produce, accounting to such person for his interest in the same; or

(b) issue such regulations for the management of the forest, waste-land or produce by the person so jointly interested as it deems necessary for the management thereof and the interests of all parties therein.

(2) When the State Government undertakes under clause (a) of sub-section (1) the management of any forest, waste-land or produce, it may, by notification in the Official Gazette, declare that any of the provisions contained in Chapters 11 and IV shall apply to such forest, waste-land or produce, and thereupon such provisions shall apply accordingly.

81. Failure to perform service for which a share in produce of Government forest is employed.-If any person be entitled to a share in the produce of any forest which is the property of Government or over which the Government has proprietary rights or to any part of the forest-produce of which the Government is entitled upon the condition of duly performing any service connected with such forest, such share shall be liable to confiscation in the event of the fact being established to the satisfaction of the State Government that such service is no longer so performed:

Provided that no such share be confiscated until the person entitled thereto, and the evidence, if any, which he may produce in proof of the due performance of such service, have been heard by an officer duly appointed in that behalf by the State Government.

82. Recovery of money due to Government.?-All money payable to the Government under this Act, or under any rule made under this Act, or on account of the price of any forest produce, or of expenses incurred in the execution of this Act in respect of such produce, may, if not paid when due, be recovered under the law for the time being in force as if it were an arrear of land-revenue.

83. Lien on forest-produce for such money.--(1) When any such money is payable for or in respect of any forest-produce, the amount thereof shall deemed to be a first charge on such produce, and such produce may be taken possession of by a Forest-officer until such amount has been paid.

(2) If such amount is not paid when due, the Forest-officer may sell such produce by public auction, and the proceeds of the sale shall be applied first in discharging such amount.

(3) The surplus, if any, if not claimed within two months from the date of the sale by the person entitled thereto, shall be forfeited to Government.

84. Land required under this Act to be deemed to be needed for a public purpose under the Land Acquisition Act, 1894.--Whenever it appears to the State Government that any land is required for any of the purposes of this Act, such land shall be deemed to be needed for a public purpose within the meaning of section 4 of the Land Acquisition Act, 1894 (1 of 1894).

85. Recovery of penalties due under bond.?When any person, in accordance with any provision of this Act, or in compliance with any rule made thereunder, binds himself by any an bond or instrument to perform any duty or act or covenants by any bond or instrument that he, or that he and his servants and agents will abstain from any act, the whole sum mentioned in such bond or instrument as the amount to be paid in case of a breach of the conditions thereof may, notwithstanding anything in section 74 of the Indian Contract Act, 1872 (9 of 1872), be recovered from him in case of such breach as if it were an arrear of land revenue.

[18][**85A. Saving for rights of Central Government.**-Nothing in this Act shall authorise a Government of any State to make any order or do anything in relation to any property not vested in that State or otherwise prejudice any rights of the Central Government or the Government of any other State without the consent of the Government concerned.]

86. Repeals.- [Rep. by Repealing and Amending Act, 1947 (2 of 1948), sec.2 and Sch.]

Important Notes of Forest Act

What is the Forest Rights Act about?

Millions of people live in and near India's forest lands, but have no legal right to their homes, lands or livelihoods. A few government officials have all power over forests and forest dwellers. The result? Both forests and people die. This Act recognises forest dwellers' rights and makes conservation more accountable.

Why is this law necessary?

What are called "forests" in Indian law often have nothing to do with actual forests. Under the Indian Forest Act, areas were often declared to be "government forests" without recording who lived in these areas, what land they were using, what uses they made of the forest and so on.82% of Madhya forest blocks and 40% of Orissa's reserved forests were never surveyed; similarly 60% of India's national parks have till today (sometimes after 25 years, as in Sariska) not completed their process of enquiry and settlement of rights. As the Tiger Task Force of the Government of India put it, "in the name of conservation, what has been carried out is a completely illegal and unconstitutional land acquisition programme."

What are conditions like in the forest areas?

Because of this situation, millions of people are subject to harassment, evictions, etc, on the pretext of being encroachers in their own homes. Torture, bonded labour, extortion of money and sexual assault are all extremely common. In the latest national eviction drive from 2002 onwards, more than 3,00,000 families were driven into destitution and starvation. In Madhya Pradesh alone, more than 125 villages have been burned to the ground.

The situation is so bad that the then Commissioner for Scheduled Castes and Scheduled Tribes, in his 29th Report, said that "The criminalisation of the entire communities in the tribal areas is the darkest blot on the liberal tradition of our country."

Why were people's rights not respected when these forests were declared?

The Indian Forest Act, 1927, India's main forest law, had nothing to do with conservation. It was created to serve the British need for timber. It sought to override customary rights and forest management systems by declaring forests state property and exploiting their timber. The law says that, at the time a "forest" is declared, a single official (the Forest Settlement Officer) is to enquire into and "settle" the land and forest rights people had in that area. These all-powerful officials unsurprisingly either did nothing or recorded only the rights of powerful communities.

The same model was subsequently built into the Wild Life Protection Act, passed in 1972, with similar consequences.

Mistakes may have been made, but surely these laws are the best way to protect our forests?

It is not just people who have lost. The very purpose of the Forest Acts was to convert forests into the property of a colonial department; and when you convert an ecosystem into someone's property, there will always be stronger claims to that property than conservation. To destroy a forest today requires nothing more than either a bribe to the local forest officer or an application to a committee in Delhi. The results include:

The loss of more than 90% of India's grasslands to commercial Forest Department plantations.

The destruction of five lakh hectares of forest in the past five years alone for mines, dams and industrial projects;

The clearing of millions of hectares of forest for monoculture plantations by the Forest Department;

Recent proposals to privatise "degraded" forest lands for private companies' timber plantations.

Moreover, the forest laws destroyed all the community management and regulation systems that had existed before, forcing people to choose between either abandoning the forest entirely or living as 'criminals' within or near it. To this day it is a criminal offence for you or I to plant a tree in a reserved forest; but it is legal for the Department to fell the entire forest so long as it has Central government permission.

What does the Forest Rights Act do?

The Act basically does two things:

Grants legal recognition to the rights of traditional forest dwelling communities, partially correcting the injustice caused by the forest laws.

Makes a beginning towards giving communities and the public a voice in forest and wildlife conservation.

Who is a forest dweller under this law, and who gets rights?

There are two stages to be eligible under this Act. First, everyone has to satisfy two conditions:

Primarily residing in forests or forest lands;

Depends on forests and forest land for a livelihood (namely "bona fide livelihood needs")

Second, you have to prove:

That the above conditions have been true for 75 years, in which case you are an *Other Traditional Forest Dweller* (s. 2(o));

OR

That you are a member of a Scheduled Tribe (s. 2(c)); and

That you are residing in the area where they are Scheduled (s. 4(1)).

In the latter case you are a *Forest Dwelling Scheduled Tribe*.

What kind of rights do forest dwellers get under this Act?

The law recognises three types of rights:

Land Rights

No one gets rights to any land that they have not been cultivating prior to December 13, 2005 (see section 4(3)) and that they are not cultivating right now. Those who are cultivating land but don't have document can claim up to 4 hectares, as long as they are cultivating the land themselves for a livelihood (section 3(1) (a) and 4(6)). Those who have a patta or a government lease, but whose land has been illegally taken by the Forest Department or whose land is the subject of a dispute between Forest and Revenue Departments, can claim those lands (see section 3(1)(f) and (g)).

There is no question of granting 4 hectares of land to every family. If I am cultivating half a hectare on December 13, 2005, I receive title to that half a hectare alone; and if I am cultivating nothing, I receive nothing. If I am cultivating more than 4 hectares without documents or a dispute, I receive title to only 4 hectares.

The land cannot be sold or transferred to anyone except by inheritance (see section 4(4)).

Use Rights

The law secondly provides for rights to use and/or collect the following:

a. Minor forest produce things like tendu patta, herbs, medicinal plants etc “that has been traditionally collected (see section 3(1) (c)). This does not include timber.

b. Grazing grounds and water bodies (sections 3

c. Traditional areas of use by nomadic or pastoralist communities i.e. communities that move with their herds, as opposed to practicing settled agriculture.

Right to Protect and Conserve

though the forest is supposed to belong to all of us, till date no one except the Forest Department had a right to protect it. If the Forest Department should decide to destroy it, or to hand it over to someone who would, stopping them was a criminal offence.

For the first time, this law also gives the community the right to protect and manage the forest. Section 3(1) (i) provide a right and a power to conserve community forest resources, while section 5 gives the community a general power to protect wildlife, forests, etc. This is vital for the thousands of village communities who are protecting their forests and wildlife against threats from forest mafias, industries and land grabbers, most of whom operate in connivance with the Forest Department.

How are rights recognised?

Section 6 of the Act provides a transparent three step procedure for deciding on who gets rights. First, the gram sabha (full village assembly, NOT the gram panchayat) makes a recommendation - i.e who has been cultivating land for how long, which minor forest produce is collected, etc. The gram sabha plays this role because it is a public body where all people participate, and hence is fully democratic and transparent. The gram sabha's recommendation goes through two stages of screening committees at the taluka and district levels. The district level committee makes the final decision (see section 6(6)). The Committees have six members - three government officers and three elected persons. At both the taluka and the district levels, any person who believes a claim is false can appeal to the Committees, and if they prove their case the right is denied (sections 6(2) and 6(4)). Finally, land recognised under this Act cannot be sold or transferred.

Indian Forest Act, 1927

The **Indian Forest Act, 1927** was largely based on previous Indian Forest Acts implemented under the British. The most famous one was the Indian Forest Act of 1878. Both the 1878 act and the 1927 one sought to consolidate and reserve the areas having forest cover, or significant wildlife, to regulate movement and transit of forest produce, and duty leviable on timber and other forest produce. It also defines the procedure to be followed for declaring an area to be a **Reserved Forest**, a **Protected Forest** or a **Village Forest**. It defines what is a forest offence, what are the acts prohibited inside a Reserved Forest, and penalties leviable on violation of the provisions of the Act.

Reserved Forest

Reserved Forest is an area mass of land duly notified under the provisions of India Forest Act or the State Forest Acts having full degree of protection. In Reserved Forests all activities are prohibited unless permitted. Reserved Forest is notified under section 20 of the Indian Forest Act, 1927 [Act 16 of 1927] or under the reservation provisions of the Forest acts of the State Governments of the Indian Union. The manner in which a Reserved Forest, shortly written as RF, has to be constituted is described in section 3 to 20 of the Act. It is within power of a State Government to issue a preliminary notification under section 4 of the Act declaring that it has been decided to constitute such land, as specified in a Schedule with details of its location, area and boundary description, into a Reserved Forest. such a notification also appoints an officer of the State Government, normally the Deputy Commissioner of the concernned district, as Forest Settlement Officer. The Forest Settlement Officer fixes a period not less than three months, to hear the claims and objections of every person having or claiming any rights over the land which is so notified to be reserved. He conducts inquiries into the claims of rights, and may reject or accept the same. He is empowered even to acquire land over which right is claimed. For rights other than that of right of way, right of pasture, right to forest produce, or right to a water course, the Forest Settlement Officer may exclude such land in whole or in part, or come to an agreement with the owner for surrender of his rights, or proceed to acquire such land in the

manner prescribed under the Land Acquisition Act, 1894 [Act 1 of 1894]. Once the Forest Settlement Officer settles all the rights either by admitting them or rejecting them, as per the provisions of the Act, and has heard appeals, if any, and settled the same, all the rights with the said piece land [boundaries of which might have been altered or modified during the settlement process] vest with the State Government. There after, the State Government issues notification under section 20 of the Indian Forest Act, 1927 declaring that piece of land to be a Reserved Forest.

Protected Forest

Protected Forest an area or mass of land notified under the provisions of India Forest Act or the State Forest Acts having limited degree of protection. In Protected Forests all activities are permitted unless prohibited. Protected Forest is an area or mass of land, which is a reserved forest, and over which the Government has property rights, declared to be so by a State Government under the provisions of the section 29 of the Indian Forest Act, 1927. It does not require the long and tedious process of settlement, as in case of declaration of a reserved forest. However, if such a declaration infringes upon a person's rights, the Government may cause an inquiry into the same; but pending such inquiries, the declaration cannot abridge or affect such rights of persons or communities. Further, in a protected forest, the Government may issue notifications declaring certain trees to be reserved, or suspend private rights, if any, for a period not exceeding 30 years, or prohibit quarrying, removal of any forest produce, or breaking of land etc. Indian forest act was established in 1927 for the protection of all the flora and fauna.

Village Forest

Village Forest is constituted under section 28 of the Indian Forest Act, 1927. The Government may assign to any village community the rights over a land which may not be a part of a reserved forest for use of the community. Usually, forested community lands are constituted into Village Grazing Reserve [VGR]. Parcels of land are so notified are marked on the settlement revenue maps of the villages.

Gene bank

-Investing in biodiversity for future generations

Gene banks are a type of biorepository which preserve genetic material. For plants, this could be by freezing cuttings from the plant, or stocking the seeds (e.g. in a seedbank). For animals, this is the freezing of sperm and eggs in zoological freezers until further need. With corals, fragments are taken which are stored in water tanks under controlled conditions.

Plant genetic material in a 'gene bank' is preserved at -280° Celsius in Liquid Nitrogen as mature seed (dry).

In plants, it is possible to unfreeze the material and propagate it, however, in animals, a living female is required for artificial insemination. While it is often difficult to use frozen animal sperm and eggs, there are many examples of it being done successfully.

In an effort to conserve agricultural biodiversity, gene banks are used to store and conserve the plant genetic resources of major crop plants and their crop wild relatives. There are many gene banks all over the world, with the Svalbard Global Seed Vault being probably the most famous one.

Preserving stocks in perpetuity

Local crop varieties, known as 'landraces', are the result of generations of careful farmer selection. Due to a combination of environmental and social changes in farming communities, and the intensification and harmonization of farming practices, large numbers of crop wild relatives and local crop varieties are disappearing at an alarming rate.

For decades, local, regional and international efforts have been attempting to preserve this valuable agrobiodiversity for future generations by setting up collections of genetic resources, called genebanks. There are currently about 1,750 institutional crop collections around the world, as well as a number of community-based seed bank initiatives, such as Debal Deb's indigenous rice varieties seed bank project in Odisha, India.

From the outset, CGIAR institutes have been involved in studying and preserving the biodiversity of their respective mandate crops. Some 710,000 accessions of cereals, legumes, roots and tubers, trees and other essential staple crops are stored in CGIAR international collections. All accessions within these collections are international public goods, available under the terms and conditions negotiated by the **International Treaty on Plant Genetic Resources for Food and Agriculture**.

Preserving these seed collections involves carrying out routine core activities, such as checks on seed health, planting to ensure seed viability and purity and good storage techniques. Adequate and continuous support is crucial for proper maintenance of the gene banks. Charlotte Lusty explained that the **Global Crop Diversity Trust** endowment was set up to offer sustainable funding for development and maintenance of the 11 existing CGIAR gene banks. The 5-year **CGIAR Research Program for Managing and Sustaining Crop Collections** (the Genebank CRP) will cover the expenses of maintaining the genebanks until the endowment takes over financial responsibility for the core costs of managing and sustaining the international collections, 'in perpetuity', for the benefit of future generations.

As well as ensuring proper maintenance and development of international collections, the new CRP will continue to strengthen **collaboration between CGIAR and national and regional genebanks**, so as to help them secure their collections for long-term conservation.

Storing and using genebank resources

The genebanks are not just biodiversity safes, preserving genetic resources for the future. They can also provide direct help to farming communities, for example by reintroducing 'extinct' landraces, or by providing material for crop breeding programs. And against a backdrop of climate change and other global challenges, and the need to consider social factors, such as consumer preferences and reduced cooking time for pulses, there has never been a greater need for as many crop variety options as possible.

Innovations are helping to improve management of the massive gene bank resources so as to respond to user requests in a more efficient way. Cases in point include the **mini core collection approach** and the**Focused Identification of Germplasm Strategy** (FIGS) methodology, which will help to enhance the use of collections by plant breeders.

Types of gene banks

Seed bank

A seedbank preserves dried seeds by storing them at a very low temperature. Spores and pteridophytes are conserved in seed banks, but other seedless plants, such as tubercrops cannot be preserved this way.[*citation needed*] The largest seed bank in world is theMillennium Seed Bank housed at the Wellcome Trust Millennium Building (WTMB), located in the grounds of Wakehurst Place in West Sussex, near London.[3]

Tissue bank

In this technique buds, protocorm and meristematic cells are conserved through particular light and temperature arrangements in a nutrient medium. This technique is used to preserve seedless plants and plants which reproduce asexually.

Cryobank

In this technique, a seed or embryo is preserved at very low temperatures. It is usually preserved in liquid nitrogen at -196 °C. This is helpful for the conservation of species facing extinction.[4]

Pollen bank

This is a method in which pollen grains are stored. We can make plants which are facing extinction in the present world. Using this technique, we can make plants with one set chromosome.

Field gene bank

This is a method of planting plants for the conservation of genes. For this purpose we construct ecosystem artificially. Through this method one can compare the difference among plants of different species and can study it in detail. It needs more land, adequate soil, weather, etc.. Germ plasma of important crops are conserved through this method. 42,000 varieties of rice are conserved in the Central Rice Research Institute in Orissa.

GenBank Overview

What is GenBank?

GenBank ® is the NIH genetic sequence database, an annotated collection of all publicly available DNA sequences (*Nucleic Acids Research*, 2013 Jan;41(D1):D36-42). GenBank is part of the International Nucleotide Sequence Database Collaboration , which comprises the DNA DataBank of Japan (DDBJ), the European Molecular Biology Laboratory (EMBL), and GenBank at NCBI. These three organizations exchange data on a daily basis.

The complete release notes for the current version of GenBank are available on the NCBI ftp site. A new release is made every two months. GenBank

growth statistics for both the traditional GenBank divisions and the WGS division are available from each release.

An annotated sample GenBank record for a *Saccharomyces cerevisiae* gene demonstrates many of the features of the GenBank flat file format.

Access to GenBank

There are several ways to search and retrieve data from GenBank.

Search GenBank for sequence identifiers and annotations with Entrez Nucleotide, which is divided into three divisions:CoreNucleotide (the main collection), dbEST (Expressed Sequence Tags), and dbGSS (Genome Survey Sequences).

- Search and align GenBank sequences to a query sequence using BLAST (Basic Local Alignment Search Tool). BLAST searches CoreNucleotide, dbEST, and dbGSS independently; see BLAST info for more information about the numerous BLAST databases.
- Search, link, and download sequences programatically using NCBI e-utilities.
- The ASN.1 and flatfile formats are available at NCBI's anonymous FTP server: ftp://ftp.ncbi.nlm.nih.gov/ncbi-asn1 andftp://ftp.ncbi.nlm.nih.gov/genbank .

GenBank Data Usage

The GenBank database is designed to provide and encourage access within the scientific community to the most up to date and comprehensive DNA sequence information. Therefore, NCBI places no restrictions on the use or distribution of the GenBank data. However, some submitters may claim patent, copyright, or other intellectual property rights in all or a portion of the data they have submitted. NCBI is not in a position to assess the validity of such claims, and therefore cannot provide comment or unrestricted permission concerning the use, copying, or distribution of the information contained in GenBank.

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sequence data, we urge authors to inform us of the appearance of the published data. As soon as it is available, please send the full publication data--all authors, title, journal, volume, pages and date--to the following address: update@ncbi.nlm.nih.gov

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If you are submitting human sequences to GenBank, do not include any data that could reveal the personal identity of the source. GenBank assumes that the submitter has received any necessary informed consent authorizations required prior to submitting sequences.

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