Environmental Quality Management

Unit

11

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Introduction

You have already learnt about types, sources and effects of air, water and land pollution on environment. n this unit we shall discuss the various aspects of environmental quality management.

Also in most of the cases, it is technically not possible to completely eliminate the generation of pollutants; it can at best be minimised. Then the question arises-to what extent can the environment tolerate the pollutants? Various countries, have set up standards which specify the limits of emission of various pollutants, viz, the maximum concentrations of pollutants that are permitted in specified media (e.g., air or water). The standards are based on : (primary) estimates of maxima which, with an allowance for safety, present no hazard to public welfare. They may take the form of emission standards, or relate to the content of products (e.g, additives or pesticide residues) in food, or phosphates in detergents. As per the pollution control acts, enacted from time to time, all the manufacturers have to adhere to these standards. Having set the standards, we now have to address ourselves to the following questions:

- What control measures are needed to bring down the emission levels to the standards set?
- What are the various issues involved in achieving the desired environmental quality? and
- At what cost could that be achieved?

We shall discuss these questions in this unit.

Management of Air Quality

The management of air quality comprises the following aspects:

a) Establishment of emission standards and ambient air quality standards
b) Measurement and control of pollution from various sources
c) Monitoring of ambient air quality to ensure that the level of pollutants is always maintained within safe limits
d) Planning of developmental activity so that the incremental pollution does not affect air quality adversely and that it remains within the permissible limits.

Air Quality Standards

Air quality standards are prescribed by Central Pollution Control Board. There are three types of standards:

i) Emission standards, which limit the emission of pollutants from a source; stock emission standards are the maximum tolerable level of a pollutant that are permitted to escape the chimney of an industry or the stack of a thermal power plant.

ii) Emission standards, which specify the ambient air quality, i.e., the amounts of various pollutants which are tolerable in space surrounding the source of generation. Emission standards are the maximum levels of a pollutant which can be tolerated in the air mass of the surrounding areas of the industry/factory or a thermal power plant. These are also called as ambient air standards.

iii) A third category of standards can be defined separately, for the sake of convenience; the vehicular emission standards. These standards have been prescribed only recently. Vehicular emission standards are the maximum tolerable limits of the levels of various pollutants that are allowed to escape the exhaust duct of an automobile.

i) Emission Standards

Various emission standards have been prescribed for different industries. The maximum permissible level of dust in the form of suspended particular matter (SPM) is 150 mg/ Nm3 (read as milligram per normal cubic metre). Dust comes from stacks of thermal power plants, iron and steel sintering plants, fertiliser manufacturing units, small industry boilers and stone quarrying activities. Other industrial units such as metal refineries, brick kilns and synthetic fibre plants belch out other pollutants in the form of acid mist consisting of droplets of dissolved gases suspended in air. These droplets consist mainly of aqueous solution of varying proportions of gases like SO2, oxides of nitrogen (NO,), CS_2, CO_2 and H_2S. The total permissible level of acid mist in the stack exhaust should not exceed 50 mg/Nm^3.

ii) The Immission Standards

The gaseous pollutants released from the stacks of various industries are ultimately deposited in the air surrounding these units, that is, in the ambient air. Obviously, regardless of how much of pollutants are released from the stack, there is a limit to the amount of individual pollutants that can be allowed to accumulate in the zone surrounding a factory, kiln or unit. The ambient air quality or emission air standards define the maximum permissible level/concentration of individual pollutants which can be allowed to prevail the surrounding air.

iii) Vehicular Emission, Standards

Automobile emissions of all types are thought to contribute 60 per cent of total air pollutants in western countries. The gases and solid particles coming from automobile exhaust pipes consist mainly of carbon monoxide, lead compounds and oxides of nitrogen (NO,), as well as un burnt hydrocarbon.

Air Quality Measurement

Air quality measurements can be made either at source (in the chimney) or in air around. Recent technical advances now enable remote measurements to be made at large heights above the ground. Measurements at the source are relatively easy to make, have better repeatability and require less time. However, they need more sophisticated instruments. Ambient air quality measurements on the other hand, require simpler instruments but are time consuming and exhaustive.

i) Measurements of Stack Emissions

The dust measurements are carried out by stack sampling. The collection of representative gaseous and particulate samples of air flowing through a stack gas is drawn through a thimble, for filtering, at a constant rate under **isokinetic conditions.** The total volume drawn is measured and the dust collected in the thimble is also measured by weight difference. The dust concentration is expressed in mg/Nm³ (volume at 25 C and 760 mm/wc).

The following three precautions must be observed during stack sampling:

- There must be sufficient number of samples,
- The long axis of the sampling probe should be parallel to and not facing the air flow direction, and
- The samples must be taken under isokinetic conditions.

Isokinetic sampling is a technique for collecting airborne suspended particulate matter, in which the sample collector is so designed that the air stream entering it has a velocity equal to that of the air passing around and outside the collector. Now, let us see what we mean by isokinetic conditions.

ii) Measurement of Ambient Air Quality

In principle, the measurement of ambient air quality is also similar to the measurement of stack air, the basic difference being that due to far lower concentration of the pollutant, compared to that in stack, the sample volume is usually very high. High volume samplers are, therefore, used. Since ambient air quality is dependent to a very large extent, on the climatic conditions, it is important that various meteorological parameters like wind velocity, wind direction, etc., are also recorded simultaneously. Ambient air quality measurements are carried out over periods ranging from 8 to 24 hours. The period of sampling for stack emission measurements depends on the concentration of the pollutants and is usually less than an hour.

Air Quality Control

A. Industrial

The control of air quality implies limiting the emission of pollutant. The conventional approach is usually called 'end of the pipe approach', in which a suitable equipment is then designed and installed to meet the pollutant emission standards. However, a more rational approach would be: to prevent generation of pollutants first and then control whatever is technically or economically not preventable.

The control systems for industrial emissions depend on the type of pollutants. The most common types of control systems for suspended particulate matter (SPM) are:

- Cyclones
- Electrostatic Precipitators
- Bag Filters
- Scrubbers

i) Cyclones/Multiclones

These are the most conventional types of control system. These work on the principle of dust separation by centrifugal force. The dirty gas enters tangentially in the cyclone and swirls in it. The dust particles get thrown on the periphery and clean gas escapes from the centre of the cyclone. Cyclone usually works at a dust separation efficiency of 70-75 per cent. The efficiency drops down sharply as the particle size goes below 10 microns. Use of cyclone is not suggestible for moisture laden gas.

ii) Electrostatic Precipitators (ESP)

The ESPs are now widely used for separation of dust in large industries like thermal power stations, cement industries, etc. They work on the principle of charging the dust by application of high voltage electricity to settle the particles down. The ESPs are simple in operation and most cost effective in larger sizes. They work with efficiency in the range of 99 per cent or even higher.

iii) Bag Filters

Of late, tremendous developments have taken place in the field of bag filters. As the name implies these consist of filter bags through which dust laden gas is passed. The dust gets filtered and clean air escapes. Bags are periodically shaken to remove the dust collected. Different types of filter bag materials are available to suit various types of dust. The common bag materials are cotton, polyester, glass wool, Teflon, polyamide and of late, ceramic fibre. Therefore, these filters are used by ceramic, cotton, insulation and textile industries.

iv) Scrubbers

Another method of separation of dust is by using scrubbers which also are the only equipment for separation of gaseous pollutants. A scrubber is an apparatus used in air sampling or cleaning, in which air is passed through a space containing wet packing material or spray. The gaseous pollutants are removed principally by scrubbing. The process consists of absorbing the gaseous pollutant in appropriate liquids to bring the pollutants from gaseous phase to liquid/solid phase. The liquid is used to remove dust particles and soluble gases from the air stream. Various types of scrubbers are available. To name a few, spray type scrubbers, ventury scrubbers, impingment scrubbers, etc. Scrubbers can also be used for removal of particulate matter; their efficiency ranges from 80 to 98 per cent. The principal disadvantages are that the gaseous pollutant gets converted into liquid/solid phase and has to be further treated before disposal. Scrubber operation is generally a costly affair as it consumes a large quantity of water and power.

B. Motor Vehicles

The major emissions from motor vehicles are:

a) Carbon monoxide
b) Un burnt hydrocarbons (soot), and
c) Nitrogen Oxides

Apart from these, lead is also emitted in case the 'petrol consist of lead based anti knocking agents such as TEL (Tetra ethyl lead). The control of vehicular emissions is usually carried out in the following ways:

a) Use of good quality petrol to minimise emissions.
b) Better tuning of carburettor and maintenance of engine, especially for better combustion which by itself brings down emissions of carbon monoxide, hydrocarbons and smoke to minimum limits.
c) Installation of catalytic convertor in the vehicles to convert nitrogen oxide into nitrogen.

Economics of Air Quality Control

The entire world has one continuous atmosphere. Obviously, therefore, air pollutants are not limited to local area but cross national and even continental boundaries. The examples of dust from Sahara desert reaching West Germany and the sulphur dioxide emissions in UK causing acid rain in Scandinavia are well known. Air pollutants, therefore, cause damage not only to the local inhabitants but also to those living in far-flung areas.

Immediate threat from air pollutants is in the form of health hazard to local population-dust causing respiratory diseases and gaseous pollutants causing several other diseases. The long-term effect is even more harmful. The breaking up of ozone layer by gaseous pollutants like chlorofluorocarbons would cause an increase in incidence of ultra-violet radiation from the sun which is a well known cancer-causing agent. The green house effect caused by carbon dioxide and other gaseous pollutants, as you have read earlier reduces the amount of heat radiated from the earth, thereby increasing the earth's temperature. The sulphur dioxide comes back to earth in the form of acid rain, which damages vast terrains of fertile land and renders soil acidic and barren. It should be obvious that it is always more economical to control air pollution than to suffer from it and then identify ways and means to cure its ill-effects.

At the unit level, dust pollution control through cyclone samplers is cheaper. Scrubbers are also cheap but require a higher operating cost due to high water and power consumption, Bag filters with indigenously available bags are not very expensive also but for industries requiring imported bags, cost can be much higher. Further, since the life of a filter bag is not more than 3 to 4 years; the recurring costs in terms of bag replacement could be considerable. Large filter bag installations may cost from several thousand ponds. ESPs are used mostly for large installations and obviously are more expensive. However, operation and maintenance costs are not very high.

Management of Water Quality

Water quality management involves multi-disciplinary approach, in which the required water quality is related to municipal, industrial, agricultural and recreational requirements. In many cases a cost-benefit ratio must be established between the benefit derived from a certain water quality and the cost of achieving that quality. Figure 12.1 shows various components to be considered while developing an effective, water quality management programme. Such a programme is designed to establish the most economic long-term

solution for achieving the desired water quality. We will now discuss its major components, viz.

i) Water quality standards
ii) Water quality measurement
iii) Water quality control

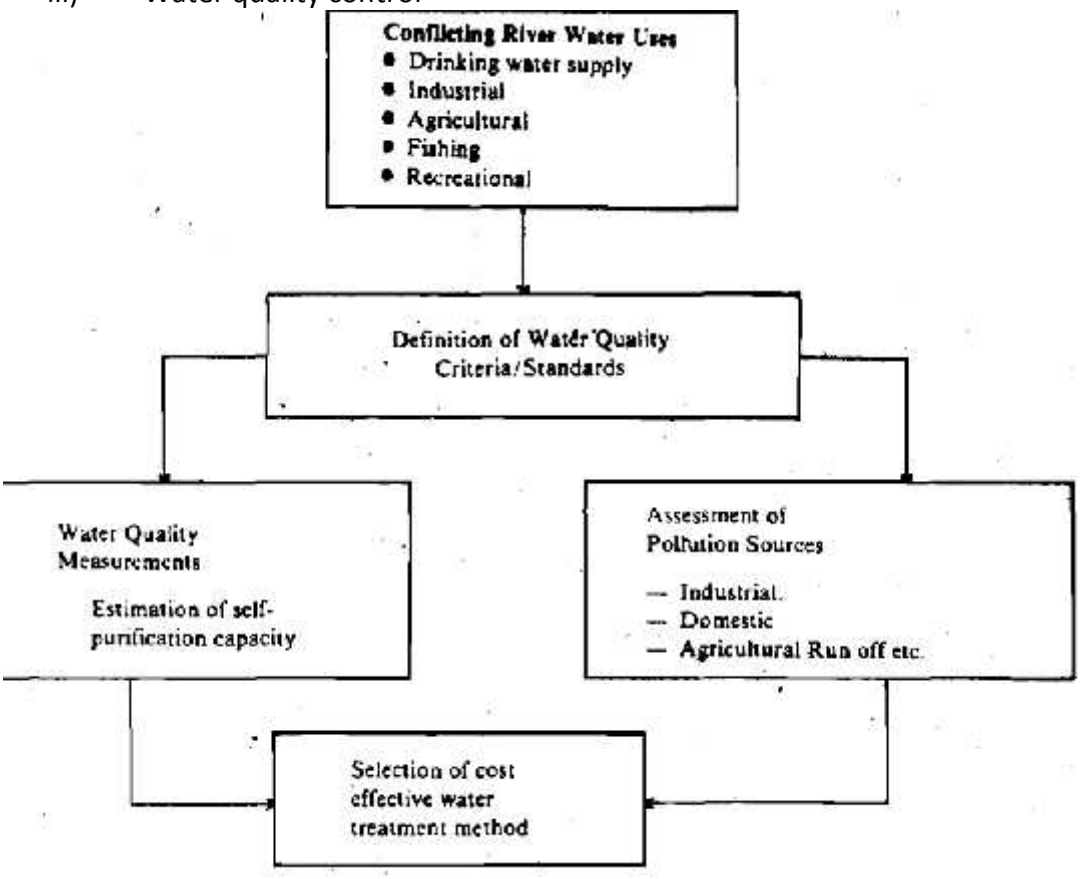

Fig: 11.1Development of a water quality management programme

Water Quality Standards

Water quality standards are based either on stream standards or on effluent standards. Stream standards are normally based on the beneficial uses of the water which fixes the threshold value of specific pollutants permissible in the receiving watt specified by the Central Pollution Control Board. For this purpose the CPCB has classified fresh Water bodies into the following broad categories:

a) Drinking water source without conventional treatment but after disinfection.
b) Organised outdoor bathing.
c) Drinking water source with conventional treatment followed by disinfection.
d) Propagation of wildlife, fisheries, and
e) Irrigation, industrial cooling and controlled waste disposal.

The waters of category A should conform to the following standards, such water should have a minimum of 6 mg/ 1 dissolved oxygen and a maximum of 2 mg/ I of biological Oxygen demand. They should not have more than 50 E. coli per 100 ml and the pH value should be between 6.5-8.5, viz., the water should neither be sour nor bitter.

The waters of category B are useful for outdoor bathing and swimming and should conform to slightly less strict criteria for quality. The waters of category C can be used for laundering. These waters can be made worth drinking by giving a conventional treatment followed by disinfection. The waters of category D are used for propagation of wildlife and maintenance of fisheries. The last category comprises of waters (E) which are not fit for any of the above purposes. These waters have very high BOD and large number of bacteria. These can, however, be used for irrigation and industrial activities provided the electrical conductivity is not more than 2,250 micro mhos per ml.

Effluent Standards are based on the maximum concentration of a pollutant (mg/ 1) of maximum pollution load (kg/day) discharged into receiving water. These standards in turn can be related to a stream classification as discussed above. Depending upon the receiving media, such as open stream or sewer or land, appropriate disposal standards have been evolved. The water pollution control act is primarily a state subject. The respective state pollution control boards are empowered to promulgate their own standards, but within the upper limits, prescribed by the CPCB.

Water Quality Measurement

Quantitative and qualitative measurements are essential to understand and control the processes affecting the fresh surface water pollution. Depending upon the objectives, the water quality measurement programmes are divided into:

Monitoring: Continuous, standardised measurement-to define the characteristics of the water resources, the nature of existing inputs and their potential pollutants.
Survey: Series of intensive programmes of finite duration, designed to carry out measurements in detail, ideal for a specific purpose and to determine the self purification capacity of the receiving media under the conditions of the survey.
Surveillance: For practical reasons related to both economic and human resources, continuous specific observations and measurements are carried out for specific pollution control or management purposes.

Parameters to be Measured

Water quality measurements are usually complex and expensive. Hence, it is important to be clear about the objective and the actual use of the collected data.

In addition to chemical and other forms of analysis, the physical behaviour of the water body needs to be considered while deciding the location of sampling points and the frequency of sampling. For gauging purposes a measuring station may be located close to the confluence, or in the middle of a large river cross section. However, for water quality measurements, the same points are unlikely to be the best location, because of incomplete mixing, and expected non-homogeneous distribution of pollutants in receiving waters used for establishing its characteristics.

Management of Land

As the years pass, the pressures on human population and of grazing animals increase, as also the demands for natural resources. These pressures and demands destroy the

vegetative cover of the land. This results in fast erosion of soil and loss of nutrients from the soil, converting large tracts of land into wastelands.

Degraded land may be of different types. It may be degraded in the form of gullied or ravenous land, it may be salt-affected land, it may be degraded due to mining or industrial activities or it may be degraded land area on account of steep slope.

Once the soil cover is lost in the process of soil erosion, it cannot be replaced. It requires a very long time for the natural processes of soil formation to recover the fertility, running into years, decades and, sometimes centuries. For example, one inch or 2.5 cm. of top soil is formed in 100 to 2,500 years.

Fertile soil supports the demand for food fodder, timber, forage, natural fibre production, etc. As the demand for these essential items grows; the need for fertile soil increases. But the tragedy is that a very large area of land has become unusable, only because of improper use. So, proper planning for use of land is essential. In addition, pollution of soil and land has to be curbed. Also, we have to improve the quality of the existing available land through reclamation. When pollutants are discharged on land, some of them may get decomposed, through the activity of living organisms present in the soil; into harmless products. Some of the pollutants are also decomposed automatically as they are not stable. For example, organic wastes do not cause great concern as these substances do not remain in soil for long. Microorganisms present in soil can decompose these materials into simpler harmless compounds. But many a pollutants remain as such in the soil for longer durations.
So, if the soil is used for raising crops, these pollutants may affect the growth of the plants, and the pollutants may also enter the plants and become a part of the food chain.

Methods to Improve Land Quality

It is essential to improve land quality to grow more and to meet the increasing demands for food and other essential agricultural items, large-scale use of chemical fertilisers is not advisable. Chemical fertilisers can improve soil and land quality, but, these are costly. Also, excessive use: of chemical fertilisers causes eutrophication of water bodies as a result the run off. Other alternative will have to be looked for. The best alternative is to utilise natural resources for land improvement.

Organic Farming

Organic fertilisers in the form of biomass and waste products cannot only provide nutrients to soil but also enrich content. Biomass is used as fuel in' the form of dung cakes, dry leaves, agricultural residues and the like. If these are utilised to improve soil quality, the benefits may be much more. Use of raw dung as fertiliser is not advisable, because if dung is raw, it attracts white ants which ultimately eat away the roots of vegetation growing in the area. Composted dung does not attract white ants and consists of nutrients in readily available form. As another version of composting the cow dung, it can be first used for generating biogas and then the decomposed product can be used as fertilizer. So, not only will the energy demand be met in a cleaner way but also the fertiliser value will be properly used.

Another way of improving land quality is to grow those plant species which add nutrients to soil. Generally, plants extract nutrients from soil. But there are certain species of plants mainly belonging to the leguminous group which fix nitrogen from atmosphere and add it to

soil. These species can grow on very poor soil and in turn, they improve the soil. So, if we have a land area which is poor in nitrogen, we may grow leguminous plants such as pea, lathyrus, dhaincha, etc. for a few seasons on the land. Care should be taken to allow maximum amount of biomass from these plants to mix with the soil. Within a short time, the soil may improve to such an extent that other crops can be grown successfully there.

Mixed Cropping

A modification of this technique can be made. Leguminous crops may be grown alternately with other crops on the land. This is called "crop rotation". So, nutrients are absorbed by one crop while the other crop makes good the loss. Slowly, the land quality improves. Another modification is "mixed cropping". Here non-leguminous and leguminous crops are grown together in the same area in a mixed pattern. So, one crop derives nutrients from the soil while the other adds.

Use of Halophytes

Unscientific irrigation may also lead to degradation in land quality. Excessive irrigation leads very often to salinisation or alkalinisation of soil. The irrigation water evaporates leaving the dissolved salts behind. Once, the soils become salt-affected, they are rendered almost useless for agriculture as crops do not grow there successfully. These areas are generally left fallow. But these soils can be reclaimed mainly by growing special types of plants' (halophytes) which are tolerant to salinity or alkalinity. When these plants grow there, the soil condition becomes better and finally other species can also be grown. They provide cover on otherwise infertile soils because, they survive better, improve the soil faster and also provide hay for the livestock.

Aerial Seeding

For difficult sites, aerial seeding practices are also adopted. Packets containing seeds along with a little fertiliser are sprayed just before rains from aircrafts and they are left to grow undisturbed. Slowly, the degraded land is transformed into productive area. A good example is afforded by hills near Islamabad, Pakistan.

Land Use Planning

It is essential to plan beforehand how land is to be used. For example, cities, highways, roads and dams should be built on degraded land areas. These requirements should be met with minimum possible disturbance to agriculture and forestry. Cities should not be permitted to grow beyond an optimum limit. Industries may be established utilising land which is otherwise useless. Agricultural production should be increased by adopting better crop management measures and technological innovations and not by bringing more areas under agriculture through forest clearance. Fallow land in the proximity of cities and towns may be costlier than these. So, the tendency is that people go for those lands for uses other than agriculture. This must be stopped.

Land use should also take into account land capability: the quality of land and the economic use to which it can be put. For example, if we use a poor quality land for agricultural purposes, the cost involved will be high and production will be low. But the same land may be suitable for growing some tree or grasses or shrub species which may be used as fuel, fodder or fibre. This type of practice should be adopted. This would generate more benefits

and also reduce pressure on other land areas. Even in the case of agriculture, proper planning is essential. Mixed cropping or rotation cropping practices should be adopted. Irrigation must be scientifically planned. Excessive irrigation should be avoided and proper avenues for drainage must be kept, otherwise the land may become salt affected. Those land areas where nothing can grow may be earmarked for buildings, roads, factories, etc.

Measures to Curb Land Pollution

Pollution of land has to be curbed. If land is polluted through (say) improper waste disposal, it will not only hamper the growth of plants and crops but may also lead to other problems. Ground water may become polluted when the pollutants percolate down the layers of soil along with runoff water. Also, as pointed out earlier, the pollutants may enter into crops and from there into food chain. Similarly, air pollutants emitted in to air finally settle down and most of these fall on land to pollute soil. For example, you might have seen that land near a thermal power station or a large factory equipments become polluted by pollutants discharged from the chimneys into air if it does not have adequate pollution control equipments. From the air, the pollutants, especially TEL (Tetra ethyl lead) as a group are very dangerous air pollution agents settle down with rains. Most of them find way to soil. If a chemical has long life and cannot easily be decomposed, it can create severe problems.

You have read that pollution of soil may be caused by different agents such as :

a) Pesticides
b) Heavy metals
c) Inorganic salts of metals and other elements
d) Radioactive substances.

Among these, radioactive substances are of limited importance as these are not used at many places and there is a strong control on manufacture, sale and use of radioactive materials. Accidentally, however, these substances may sometimes get into the environment.

A large number of these chemicals are toxic too. When these chemicals mix with soil, they create problems. Hence, it is essential to curb land pollution. This is possible if adequate pollution control measures are adopted at every level. For example, solid wastes and liquid wastes are properly treated before these are disposed.

So, an all round control on pollution is essential to curb land pollution.

Management of Forests

As a result of deforestation, further erosion of soil takes place, water availability becomes low, rains become erratic, floods become a common phenomenon, and soil nutrients are lost. All this leads to decrease in agricultural production. Similarly, when cities grow, they generally do so at the cost of agricultural land or forest land. Also, industries, highways, dams, etc. occupy large areas of agricultural land or forest land. Clearance of forest areas has also caused threat to wildlife.

Forests not only provide food and shelter for different kinds of wild animals, birds, insects, micro-organisms but they also play an important role in maintaining stability of climate and

bringing rains, etc. In addition, various species of plants and animals which come under wildlife contain innumerable genes which have already proved their usefulness or are likely to prove their usefulness.

i) Forest harvest and Management

In the 19th century, cutting of a big tree needed several man-days. Today, one person can cut a lot of trees within a day using modern machines. This is the reason why it is much more important for all of us to know how to manage forests scientifically. Efforts should be made to ensure survival of a forest with mixed age and size of plants. The complex vegetation structure has to be maintained. If there are patches of forests separated from each other, corridors of forests should be maintained between different patches, to give these patches continuity. When logging is being done, we must avoid the technique called 'clear-cut'. In this technique all the trees are cut so that the land is clear. New trees are then planted, fertilised and maintained. When the trees reach maturity, they are again cut and the process is repeated. This technique is more economical but it creates problems of soil erosion. This is the reason why clear cut forests are always under the threat of soil erosion. The other alternative available is that only selected mature trees are cut at intervals. The rest continue to grow there. So, the land and soil is never left bare. No doubt, the cost of this operation is high but it is technically more sound.

Another point is that forests should always have mixed types of trees and plants. Pure stands, i.e. of only one species are never advisable. The reason is that if there is any problem for the only species, whole forest may be destroyed. In addition, mixed types of forest provide food, shelter, etc. to animals in a much better way. Also, soil cover will be better as all round the year, some of the species will be shedding leaves while others will be green. Forest management also includes the controlling of forest fires.

ii) Social Forestry

The idea behind social forestry is to create forests with the help of society for meeting the demands of the society. Social forestry is a term used to denote tree-raising programmes to supply firewood, fodder, small timber and minor forest produce to rural populations. Social forestry programmes have mainly three components:

a) farm forestry, encouraging farmers to plant trees on their own farms , by distributing free or subsidised seedlings,
b) woodlots, planted by the forest departments for the needs of the community, especially along roadside, canal banks and other such public lands, and
c) community woodlots, planted by the communities themselves on otherwise useless lands, to be shared equally between them.

The idea of social forestry is to grow forests on any available land which is not being used for other purposes. So, the needs which are met through natural forests may be fulfilled by these forests resulting in reduced pressure on the natural forests. This can save natural forests from degradation while allowing barren lands to be utilized purposefully.