UNIT 21 ENVIRONMENTAL CONSERVATION-II

Structure

21.1 INTRODUCTION

You have gone through some aspects of environmental conservation in Unit 20. There, we discussed goals and principles of environmental conservation, conservation of endangered species of plants and animals, conservation strategies and planning for biological conservation. Now we come to the last unit of this block in which we extend these ideas on environmental conservation, to the conservation of the physical components of environment—land, water, air and energy.

Environmental conservation is an issue which has arisen from man's activities, his functional role in the biosphere, and his relationship to nature. Therefore, conservation of physical resources has to be studied in relation to his activities especially in the field of agriculture, urbanisation, industrialisation, and energy generation.

Conservation, in general, means restricting the actual demand for resource needs as well as reducing the amount used through greater efficiency and substitution of the resources. In the following pages, we would also be dealing with measures for conservation of physical resources in relation to some human activities, namely, agriculture, housing, industry, energy generation and land use.

Objectives

After reading this unit you will be able to:

- account for the changes in agricultural practices which can bring about effective utilisation of available resources, and help in their conservation.
- identify the problems arising from urbanisation and devise new ways of planning for environmentally compatible human settlements.
- correlate the problems arising from location of industries near urban centres with migration of rural people to cities.
- distinguish between the conventional and non-conventional sources of energy and suggest various means of conservation of energy.
- suggest means of recycling and reuse of solid wastes produced by cities and industries.

21.2 AGRICULTURE AND CONSERVATION OF RESOURCES

Agriculture is the mainstay of millions of Indians constituting about 60 per cent of the total population. Agriculture constitutes nearly 40 per cent of the net national product and accounts for nearly 30 per cent of the country's skilled manpower. Despite India being a predominantly agricultural country, food scarcity, widespread hunger and malnutrition have been major problems until the recent past.

The dismal situation of Indian agriculture owes its state to the irrational use of physical resources. For example, there has been wasteful use of land resources through overgrazing and deforestation for fuel and timber. Vast areas have been cleared in shifting cultivation, mainly in the hilly and mountainous regions, leading to destruction of protective vegetation cover of the soil. Indulgence in intensive irrigation has left large tracts of Indian agricultural soils either salt-affected or water-logged. You have read in Unit 8 that excessive use of fertilisers and pesticides has led to micronutrient deficiency in some instances and poisoning of the water bodies in others.

This state of affairs could change dramatically through the introduction of a sound land use policy, water conservation measures, application of solar technology in agriculture and various measures which may be classified as innovations in the field of agricultural technology.

21.2.1 Innovative Agricultural Technologies

Conservation of cultivable lands is achieved not only through preventive and remedial measures to control soil erosion (about which you have read in Unit 12), but also through the application of innovative agricultural technologies. Some of these innovations involve the use of:

Green Manures (Organic farming)
Biofertilisers
Biological Pest Control
Nitrification inhibitors
Windmills for irrigation
Solar energy for drawing ground water
Bio-gas for cooking and Spent slurry for fertilisation

We will discuss the last three technologies under the section on Non-Conventional Energy Systems. Let us become familiar with the first four conservation technologies here.

i) **Organic Farming:** No modern agricultural system is completely self-contained, and all have to rely on some form of nutrient input if yields are to be sustained. The provision of an input of nitrogen into soils from nitrogen fixation occurring in the legume root nodules (see Green manuring Section 8.4.1 of Block 2) offer an attractive alternative nitrogen source for soils. Addition of organic forms of fertilisers such as cow dung agricultural wastes improves the nutrient status of the soils. This may also help reduce the toxic effects of prolonged usage of inorganic nitrogen fertilisers in the past.

ii) **Biofertilisers:** Micro-organisms are important constituents of fertile soils. They participate in the development of soil structure, add to the available nutritional elements and improve the soil's physical condition. If an important micro-organism is absent from a soil it may be necessary to introduce or inoculate that organism into the soil. Sometimes, inoculation may also be used in an attempt to supplant an indigenous organism, which is of poor quality. This is more difficult to achieve. The introduction of root nodule bacteria into soils, usually by sticking a carrier substance onto the legume seeds, represents the initial attempts at the use of biofertilisers.

Today, a large variety of micro-organisms, mounted on suitable carrier substances, are used as biofertilisers, to improve the nutritional status of crop fields. The advantage of using biofertilisers over chemical fertilisers is that they generate fertiliser right on the spot where the nutrient is needed. This is unlike chemical fertilisers which have to be manufactured in a factory and then transported to agricultural fields. Moreover, biofertilisers generate only requisite quantities and make such quantities available to the plants in the field. Whereas, in case of chemically fertilised fields, the unused fertiliser is leached out and causes eutrophication of water bodies.

Once established in a field, biofertilisers need no subsequent inoculations, while chemical fertilisers have to be added with each crop and perhaps in increasing quantities every year. Use of biofertilisers may afford biological control of plant root pathogens but chemical fertilisers being non-living, do not provide the crop plants with protection from pathogens. Biofertilisers thus provide an environmentally safe alternative over chemical fertilisers for the modern agro-ecosystems.

iii) **Biological Pest Control:** Another application of microbiology finds its place in defending the plants against pests. Pests usually have enemies in nature but they remain inoperative because excessive agricultural production inordinately encourages the growth of pests. Biological pest control seeks to establish this ecological tool to play down the chances of survival of pest populations, through biological agents.

Care is taken to see that the agent should be specific to the pest, i.e., it should destroy only the pest concerned and not harm any other organism living in the surroundings. You have seen in Section 8.4.2, how non-specificity of chemical pest control agents leads to death of non-target organisms. Biological pest control does not carry any such dangers. A good point about biological control is that the biological agents die a natural death within a short span of time. You have seen, again in Section 8.4.2, that chemical pesticides are not biodegradable and remain active long after destroying their target-pests and prove harmful to mankind in the long run. Which means chemical agents continue to cause damage to the environment for years to come. Moreover, they are likely to enter the food chain and poison human beings whereas biological agents are not likely to harm mankind on this account. Biological control of pests is therefore an ecologically sound alternative to chemical pest control.

The first real application of biological control of pests was the discovery of milky disease of Japanese beetles. The disease involves the spores of a bacterium that contain a toxin lethal to this beetle. More recent researches have resulted in commercialisation of the spores of this bacterium containing a crystalline endotoxin that is the active ingredient for control of beetle larvae.

Another group of toxins made by a subspecies of this bacterium also kill mosquitoes and blackflies. Some 1,500 naturally occurring micro-organisms or microbial by-products have been identified as potentially useful insecticidal agents. Thus, biological control of pests is an age-old practice and should now be adopted by our indigenous farmers.

In the race to save agricultural plants from pests higher organisms are also as effective as micro-organisms. Some examples are as follows: The first large-scale use of biological control was carried out against an accidentally introduced pest of citrus fruit. This pest, the Cottony-cushion scale (*Icerya purchasi*) threatened the citrus fruit industry seriously. In this case a beetle was introduced in 1888 as a predator. The effects of this predator were that the pest was virtually eliminated within two years. The name of the control agent is ladybird beetle, and this agent continues to control the pest as effectively even today.

Another example is the recovery of 20 million ha of Australian pasture land overrun by prickly pear cactus. An insect moth was introduced to control this weed. The larvae of this moth feed on the fleshy leaves of the cactus and populations of the moth were established within a few years. After sometime much of the cactus weed had been destroyed, permitting the land to be used once more for agriculture.

Increasing use of biological control methods has become inevitable. You have read about the harmful effects of chemical control of pests in Section 8.4.2. The likelihood of successful manipulation of pest populations using biological control methods should now be put to practice.

iv) **Nitrification inhibitors:** The use of nitrogen fertilisers has increased rapidly during the past 30 years. There is increasing concern that intensive use of nitrogenous fertilisers may lead to two undesirable nitrogen transformations:

a) higher concentration of nitrate (NO_3) in surface and groundwater bodies, through a process known as **nitrification,** (you have read about nitrification in Block 1 under nitrogen cycle) followed by leaching.

Urea (Organic/ N-fertilisers) $\xrightarrow{\text{Nitrification}}$ Nitrates — **Leaching to ground water as nitrate solution**

b) Apart from the above, losses of applied nitrogen occur due to volatalisation of organic and inorganic nitrogenous fertilisers in the form of ammonia, through **urea hydrolysis.**

Urea $\xrightarrow{\text{Urease}}$ Ammonia NH_3 — **Escapes to atomosphere as gas (volatalisation)**

Chemically Nitrapyrin is 2-chloro-6-(trichlormethyl) pyridine, Didin is dicyandiamide and terrazole is 5-ethoxy-3 (trichloromethyl) — 1,2,4 — thiadiazole.

Both these phenomena are mediated by bacteria and take place in nature under conditions suitable for microbial growth. When the concentration of nitrogen containing compounds in the crop fields is increased artificially through addition of chemical fertilisers, the rates of volatalisation and nitrification rise sharply. Control over rates of urea hydrolysis and of nitrification in soils offers one approach to reducing the losses of nitrogen from inorganic nitrogen fertilisers to both groundwaters and the atmosphere. This can be achieved through the use of chemical as well as biological inhibitors of nitrogen transformations. The most interesting is urease inhibitor PPD (phenyl phorodiamidate). It slows down the hydrolysis of urea into ammonia gas, that is, reaction (b) listed above. Thus, the applied fertiliser remains available to the plants in the soil for a long time, and ultimately much less portions of the fertiliser are lost to atmosphere as gases. This improves the efficiency of utilisation of the applied dose.

Another method to meet this end is to check nitrification, that is, reaction (a) listed above. This is achieved through the use of Nitrapyrin, Didin, or Terrazole. These are three different compounds to achieve the same end. These compounds are useful in reducing the losses of nitrogen from organic fertilisers, through inhibition of nitrification and their leakage to groundwater as nitrate solution.

You may now try the following SAQ.

SAQ 1

State whether the following statements are true or false.

a) Biofertilisers are environmentally safe replacement for inorganic fertilisers.

b) Pests usually have natural enemies, but, excessive agricultural production offsets this device of nature to check the multiplication of pests.

c) The Japanese beetle is deadly crop pest. Biologists seek to control this pest by inducing milky disease in it.

d) Nitrapyrin is different from PPD because the latter is a urease inhibitor whereas nitrapyrin inhibits nitrification. Both these, however, cut down upon losses of nitrogen fertilisers to crops.

21.2.2 Energy Conservation and Agriculture

One of the natural assets of our country is abundant sunshine. The total solar radiation received in India is about 60×10^{13} MWh with 250-350 days of useful sunshine per year in most parts of the country. The daily average direct radiation at places in the central parts of the country is 5-7 kWh/m^2, read as kilo watt hours per square metre. There is thus a vast potential for harvesting this resource.

It is known, however, that only 0.1 per cent of the incoming solar radiation on earth's surface (3×10^{24} J/year) is utilised in the production of organic matter (3×10^{21} J/year) by photosynthesis. The total energy consumption in the world in year 1970 was 3×10^{20} J which is equivalent to only 10 per cent of the total organic matter

3×10^{21} J/year) produced by photosynthesis. Only **0.5 per cent** of the organic matter is utilised for food production by the world population. In terms of carbon fixation by photosynthesis, the fossil fuel reserves (4.3×10^{22} J/year) of the world would account for **5.2 days** of sunshine. While the total energy used in the whole year 1970 would account for just **53 minutes.**

These data show vast potential of photosynthetic process as also the tremendous scope for increasing the total utilisation of organic matter and that for increasing the photosynthetic efficiency. The basis of biological utilisation of solar energy is through the process of photosynthesis. Organic-chemical solar energy conversion operates at a very low efficiency 0.1 – 0.2 per cent, in other words, for every light quantum used, 1000-500 quanta are reflected back by the vegetation. However, research on a green algae, ***chlorella,*** has shown that this efficiency can be increased to about 0.6 per cent.

On the basis of extensive experimentation, the practically achievable yield of "chlorella farms" has been estimated to be of the order of 78 metric tons of dry algae per hectare. This compares favourably with agricultural yields of 4.5 – 5.6 metric tons per hectare by building large algal farms on non-arable ground. The solar energy presently absorbed by bare soil, could be increasingly utilised for the production of organic matter, for food and for conversion into synthetic liquid fuels.

21.2.3 Water Conservation and Agriculture

Irrigation is the single most important factor in our achieving a fair measure of self-sufficiency in food production. In 1947, the total irrigated area was a little over 20 Mha which in the last decade became 47 Mha. Nearly 25 per cent of the cultivated area is irrigated, which is 1/5th of the total irrigated area in any country of the world. You know that storage of water by building large dams is regarded by irrigation engineers as a crucial component of water management system. In India, too, such a high level of irrigation potential was achieved through building of large dams.

Though the benefits of these big river valley projects were three-fold, namely, (a) generation of hydro-electricity,(b) irrigation and flood control, and (c) industrial and municipal water supply; the adverse ecological implications are manyfold: deforestation, landslides, sedimentation, soil erosion, seismic activity, displacement of inhabitants and epidemic eruption of water-borne diseases are only a few of them. It is a paradox, however, that as a result of installation of major river valley projects, the total flood prone area of India instead of decreasing has actually doubled from 20 Mha to 40 Mha in the last decade.

Since Independence, more than 700 dams have been constructed. If Government programmes go ahead as scheduled, there will be hardly any free flowing river left in the country by the time the implementation of these programmes is achieved. One alternative to the big river valley projects is to construct smaller reservoirs of water and mini-hydel units for irrigation, power and city supply. This will help avoid large-scale tampering with ecological balance. Smaller units can be built, maintained and operated by local communities. The adverse side effects of these units would, certainly, be lesser. There would also be reduced chances of accidents, to which the major river valley projects are very prone. The size of these mini-projects should be such that the perennial flow of river remains undisturbed.

21.2.4 Government Agricultural Policy

The Government Policy, includes the cultivation of high yielding varieties over larger areas, development of irrigation facilities, balanced use of fertilisers and need-based plant protection measures.

India is undergoing a rapid agricultural change, wherein the whole agricultural process is yet to find its roots and adopt innovations. Barring some stabilised systems of the irrigated, subsidised and semi-commercial areas in the States like Punjab, Haryana and Tamil Nadu, most of the Indian agriculture has yet to respond to the changes that are taking place in the field of appropriate technology, especially technology suited to rural Indian conditions.

Even knowing fully the importance of conservation and preservation of the environment, authorities are sometimes reluctant to support environmentally sound innovations because of various reasons. In the Seventh Five Year Plan (1985-86) of manure, fertilisers, pesticides, insecticides and greater utilisation of improved agricultural implements and machinery were identified as the main means for achieving the stipulated target of 4 per cent increase in annual agricultural production.

But experience has shown that major increase in yields in agricultural production can be achieved through the improvement of lands hitherto classified as degraded and wastelands, through adoption of water conservation measures and through the incorporation of innovative and imaginative changes in rural agricultural technologies.

Planners have recently begun to incorporate an ecological perspective into rural development activities, such as the use of non-conventional sources of energy, use of biological control of pests and insects, use of biofertilisers, use of innovative methods of fertility regeneration suited to Indian conditions, reclamation of additional land through soil and water conservation measures, etc. In addition, tackling the twin problems of rural poverty and prevention of environmental degradation requires that good crop lands be reserved for crop regeneration. This will reduce pressure on ecologically fragile marginal lands, about which you have read in Unit 7, which tend to degrade rapidly if exploited beyond their carrying capacity.

Villagers must be motivated to plant new trees and help speedy implementation of afforestation programmes related to environment. They must be made to understand that environmental improvement will be a great boon to their entire living style and its degradation will begin a great vicious circle for them.

Excessive use of chemical fertilisers and pesticides must be curbed; instead, methods of biological control should be sought and resorted to in solving the problems of pathogenic pets, rodents and insects. All essential steps must be taken to minimise the adverse effects of excessive irrigation. Methods should be devised to achieve prudent management of water bodies.

After going through energy conservation and agriculture you may now like to attempt the following SAQ.

SAQ 2

a) State whether the following statements are true or false by putting T/F in the boxes provided.

   i) Only 0.1 per cent of the incoming solar radiation on earth's surface is utilised in the production of organic matter by photosynthesis. ☐

   ii) India has 1/5th of the total irrigated land in the world and also the largest irrigated area in any country of the world. ☐

   iii) The dismal situation of Indian agriculture could change through introduction of sound land reform policy, water conservation measure and application of enery saving technologies in agriculture. ☐

   iv) Biological control of pathogenic pests, rodents and insects is a better method over the excessive use of chemical fertilisers and pesticides from conservation point of view. ☐

b) Fill in the blanks using appropriate words:

   i) Though the benefits of big river valley projects are threefold, their adverse ecological effects are many; for example, deforestation, ... sedimentation, ..., seismic activity, ... and eruption of .... diseases.

   ii) As a result of installation of major river valley projects, the total flood-prone area has .... from 20 Mha to 40 Mha in the .... decade.

21.3 URBANISATION AND CONSERVATION

Urbanisation is a global phenomenon with its firm roots in the developed communities of the world. As a continuing spatial process, it is now taking a steady stride in developing countries as well. Moreover, urbanisation within the diversified economic systems of these communities is often taken to be synonymous with development. Hence, the degree of urbanisation has increased tremendously, which means that:

i) the proportion of urban population has increased,

ii) the population density of towns has increased, and

iii) the percentage growth of population in the decade (1971-81 in case of India) has increased.

These three parameters which are known as volume, spatial spread and decadal growth, respectively, form the three indices of degree of urbanisation. In case of India, the increase in the degree of urbanisation is largely due to a steady migration of rural population from rural to urban areas. However, there are big lacunae in urban planning whereby there is inability to keep pace with the increasing demand, resulting in a haphazard growth of urban settlements.

One important aspect regarding development is the controversy concerning place versus people development. Congregation of a large number of families, and their settlement in areas surrounding the city, leads to the formation of million plus cities, that is, cities having a population of more than one million or 10 lakhs. The million plus cities have experienced a sharp increase in their population. According to 1971 Census there were 9 such cities in India, whereas their number has gone upto 12 in 1981 and the population of these cities has increased from nearly three crores to over four crores within these ten years. Table 21.1 shows the population and its growth rate in 12 major cities of India.

Table 21.1 : Population of Some Major Cities of India (in lakhs)

Cities	Population in Lakhs 1971	1981	Percentage Increase over past ten years
Calcutta	70.3	91.6	30.3
Bombay	59.7	82.3	37.8
Delhi	36.5	57.1	56.6
Madras	31.7	42.8	34.9
Bangalore	16.5	29.1	76.2
Hyderabad	18.0	25.3	40.7
Ahmedabad	17.4	25.1	44.1
Kanpur	12.7	16.9	33.0
Pune	11.3	16.8	48.6
Nagpur	9.3	13.0	39.8
Lucknow	8.2	10.1	23.2
Jaipur	6.2	10.1	58.7

The main reason for heavy concentration of urban population in large metropolitan cities is that they are the centres of major industrial and commercial activities, besides being the seats of administration. As such they offer much attraction for migration of people and this accounts for a rapid increase in their population.

You have read about effects of unplanned urbanisation in Unit 12. The rapid rate of urbanisation has led to concentration of about 80 per cent of the industrial activities in big cities. For example, you have seen that in Bombay alone 3000 industries are located. This leads to migration of rural people to the cities in search of jobs, resulting in overcrowding and formation of unplanned hutments and slums. The shortage of houses in urban areas has resulted in growth of such areas where sanitation facilities are poor, there is acute water and electricity shortage often resulting in the spread of water borne and air pollution diseases.

21.3.1 Challenge of Housing

As cities grow in size, the facilities which they provide for their inhabitants become a matter of concern for planners. In India, the situation seems to be more alarming due possibly to the clustered pattern of urbanisation and migration of rural population specially into the million plus cities. This results in increased burden on the carrying capacity of the city ecosystem. As a result, the public experiences an acute shortage of houses. There was a paucity of about 4.8 million urban houses in 1981 which is expected to rise to about 7.2 million by the end of 1991. The challenge of housing comprises in providing potable water, electricity and sanitation facilities to these sections of the society.

The fact remains that agricultural land cannot support all the population living in the rural areas. We would like you to read Section 8.3.1 again where we have described how the destruction of small-scale traditional occupations leads to further deforestation at an increased pace. The need, therefore, is for exploring alternate avenues of employment for rural population like small-scale industries, handicraft such as potteries, textile printing, weaving, sculpturing and the like. Sufficient incentives should be provided to the rural poor to find job opportunities based on small-scale village based occupations such as honey collection, basket making, sericulture, collection of medicinal plants, lac, amber and other non-destructive forest produce, so that they do not need to migrate to the cities.

21.3.2 Planning for Environmentally Compatible Human Settlements

To provide environmentally compatible human habitations, a multipronged approach for conservation of urban environment should be followed. Some of the points which may be kept in mind are:

1) In all urban areas sufficient green area must be demarcated and maintained around construction sites to compensate the heating effect of concrete buildings. If some trees are felled, new trees must be planted to maintain the balance. Wherever land is available, people must be encouraged to plant and nurture trees.
2) Illegal encroachments should never be regularised and if such encroachments have been at the cost of cutting of trees, stringent action against the party involved must be taken. You will read about the legislative measures which have been taken to stop encroachment on fertile, productive lands in Unit 23.
3) Prior to the approval of city water supply scheme, a linked drainage scheme should be provided for all new constructions and buildings.
4) Since cities are suffering from the polluted exhausts and effluents emanated by industrial establishments located in their close proximity, separate water treatment facilities must be used for commercial and residential water supply. Similarly, their discharges should be collected separately. The industrial effluents must be given special treatment before being discharged into receiving waters.
5) Commercial activities which can generate hazardous liquid waste, such as electroplating, metal finishing, plastic and polyvinyl products, paints and ink factories, should not be allowed to encroach on residential areas.
6) Sewage recycling projects must be initiated in all big cities of India. This will help in quick and safe disposal of sewage and at the same time help recover the energy content of organic residues resulting from household activities. You will read about this in another section.

21.3.3 Strategy for Sustainable Industrial Development

The rapid industrialisation process has led to serious deterioration of environment both on the peripheral regions and within the city. There is a clear trend towards increase in concentration of industries on the fringes of cities in India. About 80 per cent of the total industrial production is accounted for by industries located only in 12 big cities. The industrial pollution affects not only the lives of 162 million city dwellers but also the forests and trees growing in the vicinity of the city resorts and metropolices.

To contain and control the adverse effects of industrialisation on environment, regulation of land use measures must be undertaken. In addition to the existing million plus cities, a few **Satellite cities** should be created around the million plus cities. While catering to the local needs of the satellite cities, this will enable each region to make use of the infrastructural services of the big city, such as transport, recreation and communication system.

Industries must be classified into different categories and an effort must be made to ensure that water-intensive industries like paper industry, are located in areas with plenty of water. Whereas, in areas of water scarcity only such industries must be allowed which are not water-based, like electronics. Industries must also have a separate cell to safeguard against environmental pollution. Such cells must undertake continuous study of the level of environmental pollution, suggest appropriate measures and force the concerned industrial units to take adequate measures for environmental protection. This means that the industries ought to make necessary changes in their equipment in harmony with eco-balance. The technological change should complement the spirit of sustainable development, i.e. it should enhance the current and future potential of resources to meet human needs and aspirations.

After reading about the challenges of housing and strategy for sustainable industrial development, let us attempt the following SAQ.

SAQ 3

a) Match the terms given in column A with the definitions given in column B.

	Column A		Column B
i)	Million plus cities	1.	The number of people living in a unit area of of the city.
ii)	Migration	2.	The percentage growth in population over a decade (ten years).
iii)	Decadal growtn	3.	Mass movement of people from one place of settlement to another.
iv)	Spatial spread	4.	Cities having a population of more than one million people.

b) Fill in the blank spaces using appropriate words and compare your answers with those given at the end of this unit:

i) Congregation of a large number of families and their settlement in areas surrounding the city leads to formation of ....

ii) The three indices of increase in degree of urbanisation are, increase in ...., spatial spread and ....

iii) According to 1971 Census, the number of million plus cities in India has gone up from 9 to 12. The three cities which have become million plus in this period are Nagpur, ..., and Jaipur.

iv) In all urban areas sufficient green areas must be demarcated and maintained around construction sites to compensate the ....

21.4 FUTURE ENERGY NEEDS

Energy is an essential input for industrial development. Energy is produced from commercial sources like coal, petroleum, hydroelectric schemes as well as from non-commercial sources like cowdung, fuelwood and agricultural wastes. Per capita consumption of commercial energy is sometimes used as an index of the economic advancement that a country has attained. India's per capita consumption of commercial energy, however, is very low. It is only one eighth of the world average.

Commercial energy accounts for a little over half of the total energy used in the country, the rest coming from non-commercial sources. Share of agriculture in commercial energy consumption has risen rapidly over the past two-and-a-half decades. Industry consumed about 78 per cent of the coal and 62 per cent of the electrical energy in the country in 1985-86. The transport sector accounted for 56 per cent of the total oil consumption during the year 1989. The energy consumption of these sectors as well as the household sector are increasing rapidly. The energy strategy, therefore, has to plan not only for an increase in indigenous availability but also aim at its efficient utilisation.

21.4.1 Conservation and Energy

Energy generation and environmental conservation are the twin issues arising from exploitative interaction of man with natural resources. A 1987 report of the

International Energy Agency contains a simple but remarkable statement: "Investment in energy conservation at the margin provides a better return than investment in energy supply." Now, what do we mean by this? This means that conservation of a unit of energy is cheaper and environmentally more desirable than to generate an additional unit. For, it is estimated that generation of every additional kilowatt hour of energy requires an investment of Rs. 7,000 to 12,000 in the form of new energy generation equipments.

Excessive utilisation of coal and oil for generation of electricity leads to the multiple problems of acid rain, and rising carbon dioxide levels in the atmosphere. There are also political and economic implications like the increasing tension in the Persian Gulf which is the major petroleum exporting area, and falling international competitiveness. All these threaten to strangle the world economy in a stagnation. Let us see how some steps taken to resolve these complex problems have tangled the issues further.

To reduce dependence on oil for generation of electricity by burning coal and oil, hydroelectric power stations and atomic energy stations were advocated. Huge dams can make substantial contributions to economic development in electricity-short developing countries like India, but as in any large-scale electricity generating option, there are trade-offs. Reservoirs inundate forests, farmland and wildlife habitats and uproot entire communities of indigenous people. A million people will be forced from their homes in Central India if a project to build all the small and big dams in the Narmada Valley is pursued. The setting up of hydroelectric power stations, also known as hydel plants, upsets the isostatic balance of the area, submerges the surrounding animal — and plant — populations, renders the local inhabitants jobless and homeless. Thus, hasty solutions to a given problem may create more complications rather than solving it.

In the recent past, countries have been expanding their energy budget presumably thinking that energy expenditure was the only way to development, but today the perspective has changed. One of the greatest challenges facing poor countries is to meet their energy needs without repeating the mistakes made by the rich countries. A goal of reducing national energy expenditure, if pursued rigorously, can lead to a strong emphasis on energy efficiency, improve economic competitiveness, and limit oil dependence. A policy of **Polluter pays** must be adopted. In effect this means specific disincentives are required to ensure that industries do not become too heavily dependent on fossil fuels that threaten life-support systems. The need of the day is to "insist on industries adopting clean technologies wherever available".

The answer to the country's energy needs can only lie in adopting non-conventional sources of energy. A beginning is being made by Government of India to give the same type of resources and support to developing alternative sources of energy as have so far been extended to the development of conventional energy sources. The latter, as experience has shown, pose a great danger to the environment. Many environmentally safe alternatives have been found today, which await encouragement from the Government for proper exploitation.

21.4.2 Conventional and Non-Conventional Energy Sources

Energy is produced mainly from non-renewable sources such as petroleum, natural gas, coal and lignite. They are usually referred to as non-renewable, because extraction from the stock depletes the usable quantity remaining. And even if some is being formed, the rate of formation is too slow compared to the time scale of their utilisation. The non-renewable sources are also called fund or **stock resources.** They are also called **conventional sources** as they use age-old technologies for energy generation.

Energy can also be produced from other natural resources, such as living organisms and their products, by trapping solar radiation. These resources are called **renewable resources** or **flow resources** because they involve organic growth and reproduction, also because they are relatively quickly recycled or renewed in nature, as in case of water in the hydrologic cycle. The renewable sources of energy are also called **non-conventional sources** of energy because the techniques for their exploitation have been developed comparatively recently. These are also referred to as alternate sources of energy because they offer an alternative to conventional sources of energy.

The energy sources and their manner of use may be categorised as conventional and non-conventional or commercial and non-commercial, renewable and non-renewable, and terrestrial or solar, etc., but the environmental impact of these energy sources cannot be readily understood in isolation. However, one thing is certain that energy efficient systems will have to be developed to make the goal of self-reliance a reality.

The means of conserving energy are by nature fragmented and unglamorous. Use of biogas plants, draught power, bullock-carts, insulated mud houses, collection of rain water on house tops, conservation of polyethylene packets, recycling of solid wastes (Section 21.4.4, p. 69), and so on are not perhaps intrinsically as captivating as atomic power stations or orbiting solar collectors. But, we should not forget that, infatuation with such grandiose energy supply options has got us into our current predicament. We should now concentrate upon simple but useful alternatives of energy sources which are environmentally compatible and economically within our reach.

In the following sections we will study some of the important means of energy conservation through the incorporation of innovative and imaginative alternatives within conventional rural agricultural technologies.

21.4.3 Development of Non-Polluting Energy Systems

In developing countries like India, the energy needs of rural poor are mostly met with by burning firewood. Traditional methods of cooking are very unhealthy for the cook, as they emit a lot of smoke. Also the heat released in burning is not efficiently utilised. Indian energy scientists have come up with smokeless **(chulhas)** stoves specially designed for Indian conditions. These 'Chulhas' are smokeless, permit shorter cooking time and there is also saving of fuel.

I. Smokeless Chulhas: The fuel in smokeless 'chulhas' is renewable. Wood and straw are packaged solar energy that is used by plants as they grow. In the process they absorb carbon dioxide from the air and thus help reduce green house effect. When plant parts are burnt as fuel, the carbon dioxide is released again... but it will be reabsorbed in an endless cycle as long as trees keep growing and fields are replanted.

The improved 'chulha' has invoked tremendous response and positive action from all concerned. Nearly 3,000 villages have been rendered 'smokeless' in the sense that in each house of these villages, either an improved 'chulha' or a biogas plant is used for cooking food. A trained work force of more than 50,000 persons, mainly women, was created to work as master craftsmen for constructing the improved chulhas.

II. Gobar Gas: Another alternative is biogas, also known as gobar gas. Gobar gas, which is largely methane, can also be generated from wood and straw, in specially built digesters. These can be afforded by any farmer who owns two to three cattle heads. The dung is collected and diluted with water along with straw, wood shavings or other agriculture or abattoir residues. The range of raw materials that can be digested in gobar gas digesters is in fact very wide, kitchen wastes, human nightsoil, piggery refuse, waste newspapers, city sewage. Almost any natural organic matter you can think of can be digested to produce gobar gas (methane) which is collected in the dome above the digester, from where it is taken to the kitchen through pipes and burnt in gas burners for cooking.

Its other benefits include reduction of indiscriminate felling of trees for fuel, improvement in sanitation, reduction in the incidence of eye disease among village women and easy and efficient cooking. One of the greatest merits of **gobar gas** is its versatility. It can be used for cooking, lighting and power generation, running refrigerator, or tubewell pump sets. Another advantage of biogas digester is that the material left over after digestion, which is known as **spent slurry**, is a good fertiliser, rich in NPK (nitrogen, phosphorus, potassium). The spent slurry, if applied to fields, is known to increase yields because along with the NPK it contains significant number of bacteria beneficial to the crops.

There is only one difficulty with biogas digesters; their efficiency goes down during winters when the atmospheric temperature is low and the need for energy is acute. However, in tropical countries like India, this may not pose a serious problem. Moreover, this problem can be tackled by using initial traces of gas coming from the dome in heating the digester itself.

The Government of India provides subsidy and extends technical know-how for installation and running of the gobar gas digesters. In view of the large social benefits of biogas energy, the National Project on Biogas Development (NPBD) was taken up the promotion of biogas production in the country. Under this project 9,29,981 biogas plants were set up upto the end of 1989, the latest figures available. Of this, Maharashtra has the maximum number of 2,46,216 family sized biogas plants.

III. Energy from City Sewage: The city sewage treatment plants use anaerobic digestion units for extracting methane from human nightsoil which is in the form of a sludge. The gas generated from the sludge is called sludge gas, which like biogas consists largely of methane. The Department of Non-Conventional Energy Sources has supported setting up sewage based biogas plants in Uttar Pradesh, Madhya Pradesh and Delhi.

One large size urban waste recycling plant is already operating at Okhla, Delhi. The plant comprises 15 digesters connected to 15 gas collectors. The total gas generation from the plant is about 0.6 million cubic feet per day having a heat value of 700-800 "BTU" per cubic foot (equivalent to 500-570 cal per m^3). The gas is being supplied to about 800 households over an area of four kilometres. The gas is about 50 per cent cheaper than the LPG gas. Another such project has been commissioned, recently at Pandraune in UP. Plants are under construction at Ayodhya in UP, Eshaopur in Delhi, and at Bhopal in MP. In Jabalpur, Municipal Corporation is setting up a garbage-based power plant which will generate 7 MW electricity daily.

Many bioorganic wastes are released as by-products by distilleries in India. A new technology for waste recycling and disposal has been introduced for the first time in the country by a distillery in Gujarat. The technology, simultaneous with the treatment of 45,000 litres of waste, will generate energy equivalent to that given by 10 tonnes of coal every days. The fuel is generated from the waste after fermenting the ash with yeast in a suitable culture medium. The 10 million litre capacity distillery can get 50 per cent of its fuel requirement from recycling its own waste. If all the 150 distilleries in the country adopt the technology there could be a saving of Rs 30 crores or 5,00,000 tonnes of coal annually. This will also result in an environmentally safe disposal of wastes!

Similarly National Environmental Engineering Research Institute has installed digestion units at Nagpur. The Commission for Additional Resources of Energy has set up its units, one each at Chandigarh, Hyderabad, Bhopal, Ahmedabad, Lucknow and Guwahati.

Plans are being made for setting up sewage gas plants in the riverside towns like Varanasi, Allahabad, Agra, Kanpur and Bangalore. The Department of Non-Conventional Energy Sources has been active in preparing plans for depolluting the Ganga.

IV. Solar Energy: Biogas is a cheap and efficient fuel and its feedstock is renewable. More recently, other renewable sources for energy generation are being explored. Systematic efforts, for example, are being made to tap solar energy for meeting the demands of our rural poor. It is a decentralised energy system, which can be used to meet versatile needs of the Indian masses. Solar cooking, water heating, water desalination, space heating, crop drying, etc. are some of the **modes of thermal conversion.** Efforts are on to economically develop solar collectors for high temperature applications. More than 380 solar water heating systems are operating in the country. More than 1,000 large capacity water heating systems are under installation.

Solar energy can also be converted into electrical energy. Solar panels concentrate large amounts of light energy on photovoltaic cells which charge the batteries that serve as a source of electricity. This electricity can be used to run pumps, street lighting system or even refrigerators. More than 160 solar photovoltaic pumps have been installed in the rural areas providing water for drinking and irrigation. Solar photovoltaic street lighting systems have been provided by Govenment of India in more than 150 villages on experimental basis. Installed in the remote villages, also known as **Urjagrams,** far from power lines, solar energy makes electricity available to people who would otherwise not be able to dream of thermal or hydel electrical energy.

V. Wind Energy: Another renewable alternative source of energy is wind energy. Wind energy holds promise for systematic utilisation. The maximum exploitable potential has been estimated at about 3.2×10^8 J/year. It can be converted into mechanical and electrical energies and would be particularly useful in remote areas. Wind energy can be made to run turbine to generate electricity. According to Indian Meteorological Department average annual wind density of 3 kWh/m^2/day (read as kilo watt hours per square metre per day) is prevalent at a number of places in Peninsular and Central India. In some areas, the densities are higher than 10 kWh/m^2/day during winter when energy requirements are very acute and 4 kWh/m^2/day for 5-7 months in a year. At present this energy is being used to upwell groundwater at four locations in Ajmer in Rajasthan. DNES has installed 924 wind pumps throughout the country. Wind electricity generators at appropriate locations (like Ladakh) are envisaged with aggregate capacity of 2 MW (Megawatts), for lighting and pumping water in addition to devising charging of batteries (see Table 21.2). In the 8th Plan, some 85 new wind-powered mills are proposed to be installed at various locations in India, where the aerodynamics of the area provides conditions suitable for this venture.

Today, there are more than 100 manufacturers in the country engaged in the production and development of different renewable energy systems and devices. It is estimated that by the end of this century, 20 per cent of the total energy demand will be met from the following non-conventional energy sources listed in Table 21.2.

Table 21.2 : New and Renewable Sources of Energy (NRSE) Systems and Devices Installed in the Country

Systems	**Installed upto Feb. 87**
Family size biogas plants*	7,37.000
Community/Institutional Biogas Projects**	226
Improved Chulhas	24,18,000
Domestic Solar Hot Water Systems	1,170
Solar Kilns	34
Non-domestic Solar Hot Water Systems	1,001
Solar Crop Driers	28
Solar Water Distillation Units	5,940
Water Pumping Windmills	1,603
Solar PV Street Lighting Systems	6,193
Solar Photovoltaic Pumps	659
Solar PV TV and Community PV Lighting Systems	337
PV Battery Charging Units	611
PV Medical Refrigerators	1
Aerogenerators	18
Wind Farms (Total capacity)	3.65 Mw
Domestic Lighting Systems	100

* Average capacity of each plant 4 m^3 per day.

** Average capacity per project 100 m^3 per day.

PV = Photovoltaic

Source: Annual Report of Department of Non-Conventional Energy Sources, 1986-87.

Try the following SAQ to see what you have understood of the various non-conventional sources of energy. Compare your answers with those given at the end of this unit.

SAQ 4

a) What is the difference between commercial and non-commercial sources of energy?

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b) State whether the following statements are correct/incorrect. Indicate your answer by putting a (√) of (×) in the boxes provided.

i) City sewage cannot be used for generation of biogas. ☐

ii) Smokeless 'Chulhas' permit shorter cooking time along with saving of fuel. ☐

iii) Gobar gas or biogas can be used for cooking, lighting and power generation for running refrigerators or tubewell pump sets. ☐

iv) Urjagrams are earmarked villages in which non-conventional alternate energy generating systems have been installed by Government on experimental basis. ☐

c) Compare and contrast conventional versus alternate systems of energy generation.

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21.4.4 Solid Waste Management

We have mentioned under Section 21.4.2 that reuse and recycling of solid wastes can also serve as a means for conservation of energy. In the light of this, let us see, what are the principles guiding the management of solid wastes. Recognising that our resources are finite and continued pollution will be difficult to rectify in coming times, the management of solid wastes has become important. Before disposal, a waste should be considered for the following possibilities:

- Reduction in raw materials and solid waste quantities
- Reuse of waste materials
- Materials recovery
- Energy recovery

About these you have read in Unit 17, at length.

I) Reduction in Raw Materials and Solid Waste

Solid wastes are generated at the start of the process beginning with the mining of raw material. Thereafter, solid wastes are generated at every step in the process of conversion of goods into products. The products are then used by the consumer whence again wastes are generated. Clearly if a reduction in the usage of raw materials is to occur the quantity of waste must be curtailed. This can be achieved by

i) reducing the amount of materials used in the manufacture of a product,
ii) increasing the life of the product, and
iii) reducing the amount of materials used for packing the consumer goods.

II) Reuse of Waste Materials

Reuse of waste materials now occurs most commonly in those situations where a product has utility in more than one applications. For example, the paper bags used to bring home groceries are used to store household wastes prior to placing them in containers used for storage for collection. Soup and vegetable containers are used to store cooking medium, like ghee or oil. Newspapers are used to start fires in fireplaces; they are also tightly rolled and used as logs for burning. While all the above reuses are important, their impact on generation of solid wastes is minimal. A much larger impact would occur if this habit is encouraged on a large-scale, in urban and town communities.

III) Material Recovery and Recycling

A number of materials present in municipal and industrial wastes are suitable for recovery and recycling about 10-15 per cent of solid waste are recoverable. Most suitable candidates are the wastes generated by paper, cardboard, glass, ferrous metals, nonferrous metals (mostly aluminium) and rubber. On the contrary, plastics, leather, textile and food wastes are unsuitable candidates for materials recovery. This is why, it is advisable to save on the number of polyethylene packets, when purchasing consumer goods.

Fly ash which is a dust like by-product of the thermal power plants, is produced in huge quantities. Over 22 mt of fly ash from thermal power sector was available for utilisation in 1985-86. It appears that the fly ash can be compressed into bricks as such or in combination with cement etc., that can be used for building houses.

IV) Energy Recovery

After segregation of wastes in the above-mentioned categories, the remainder is considered for the recovery of heat by burning (incineration). Because about 70 per cent of the components that comprise solid waste are organic, the potential for recovery of heat energy is high. The energy content in the waste matter is converted to a form that can be used more easily. The remainder (ash) is also more compact and weighs less, occupying a smaller volume.

A wide variety of waste construction materials, municipal sewage and industrial by-products, forestry waste and urban waste (like rags, plastic bags, newspapers, etc.) are generated by modern human activities. Such wastes can be used for incineration to recover their heat energy. For instance, about 10 per cent biomass produced in paddy fields forms rice grain, the remaining 90 per cent is usually burnt but can be put to good use. If burnt in skillfully managed incinerators, **paddy straw** turns out to be far cheaper (about one third) than coal as a fuel for power generation. It has substantial energy value ranging from 3,200 to 3,500 kcal/kg. The availability of paddy straw is also good. In Punjab alone, about 5 Mt paddy straw is available. In remote areas, for power generation through small and medium units, the bulk of power needs of the farm sector can be easily met by using paddy straw.

Conservation of Physical Resources

Man is an integral part of the biosphere and therefore, is totally dependent on its resources. His future and even his survival, depends upon the rational use and conservation of the resources available to him.

If the environment is to continue to sustain life, it must be protected from the consequences of our own actions. Breathable air, clean water, fertile soil, and innumerable life forms, are all important resources that are vital to our own survival. This is particularly important because physical resources are limited.

21.5 SUMMARY

In this unit we have tried to view the principles of conservation of physical resources, and learnt that:

- Degradation in physical resources such as land, water, air and soil results mainly from exploitative activities of man in the fields of agriculture, industry, urbanisation and energy generation.
- Conservation in agriculture can be affected by changes in land use patterns, conservation of irrigation water and energy, minimisation of use of pesticides and fertilisers and implementation of innovative and sound environmental techniques of agriculture.
- Conservation of sources of energy is urgently needed as its excessive consumption is not only costly but also leads to multiple problems. Moreover, dependence of modern man on innovative and non-conventional sources of energy has become the only alternative.
- Management of city waste, with emphasis on minimisation, reuse and recycling, is one of the best means of conservation of resources.

21.6 TERMINAL QUESTIONS

1) Compare the advantages/disadvantages of the use of biofertilisers with those of the use of chemical fertilisers.

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2) Compare and discuss biological control of pests with chemical pest control agents.

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3) Give two examples of changes in agricultural practices which can bring about effective utilisation of available resources, and help in conservation of resources.

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4) How does the location of industries near urban centres generate problems for city dwellers?

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5) What are the differences between conventional and non-conventional sources of energy?

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6) Suggest two non-conventional means of generating energy.

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21.7 ANSWERS

SAQ 1

1. a. T b. T c. T. d. T

SAQ 2

a) i) True ii) True iii) True iv) True

b) i) landslides, soil erosion, displacement of inhabitants, water borne diseases
ii) doubled, last

SAQ 3

a)

Column A	Column B
i	4
ii	3
iii	2
iv	1

b) i) million plus cities
ii) volume, decadal growth
iii) Lucknow
iv) heating effect

SAQ 4

a) The sources of energy which are produced on a large-scale for the purpose of sale are called **commercial,** such as coal, petroleum, electricity. Those sources which serve only local needs and are not produced on a large-scale are called **non-commercial** sources such as firewood, cowdung and agricultural wastes.

b) i) × ii) (√) iii) (√) iv) (√)

c) Conventional systems of energy generation are less efficient, more polluting and non-renewable. Whereas alternate sources of energy are innovations providing clean and efficient means of energy generation using renewable resources.

Answers to Terminal Questions

1) Use of biofertilisers can replace the use of chemical fertilisers. The latter are manufactured and transported to agricultural fields at high energy costs. Also, they have to be added to fields every year in increasing quantities, thereby causing increasing damage and decreasing returns with successive applications. Whereas biofertilisers produce just the right quantities at their point of utilisation, making use of solar energy without causing pollution problems.

2) Biological control of pests, is better than the use of pesticides because of the following reasons:

S.No.	Biological Agents	Chemical Agents
1.	Are target-specific, narrow-range agents	Are not target-specific, broad-range agents
2.	Die natural death after destroying the pest	Remain active long after destroying the pest
3.	Do not cause environmental damage	Can cause food poisoning and enter human food chain

3) Use of solar farms and installation of small dams are two important changes in agricultural practices which can save on energy and water resources respectively. These two represent environmentally sound alternatives to the present day energy intensive, devastative practices of large-scale agricultural production.

4) Location of industries near urban centres leads to water and electricity shortage, because industries compete with city dwellers for these resources. This leads to poor sanitary conditions in cities and to spread of water borne diseases, air pollution diseases and the like.

5) The conventional sources of energy such as coal, petroleum are non-renewable; they make use of old technologies for energy generation and cause environmental damage. Non-conventional sources of energy such as solar energy, energy from biomass, are based on renewable resources; they make use of comparatively recent technologies and cause minimum damage to the environment. Non-conventional sources of energy are decentralised means of making energy available to rural poor located in remote areas.

6) The two non-conventional methods of energy generation are: a) generation of electricity through solar cells, and b) generation of electricity through wind power. In the first case, solar panels collect solar radiation and reflect it on photovoltaic cells, which become charged and can be used as battery of cells. The second makes use of force of wind to rotate a motor which generates electricity.

GLOSSARY

abbatoire: wastes generated by meat-processing industry.

B.T.U. (British Thermal Unit): a unit chosen for comparison of quantities of heat. It is the amount of heat required to raise the temperature of one pound of water by 1° F. 1 BTU = 252 cal.

catchment (area): an area from which water drains to a particular location such as a main river system or a lake.

chemical fertilisers: compounds of nitrogen, phosphorus and potassium, when added to soil stimulate growth of crops. Many of these are water soluble and if not taken up by plants, are easily leached away. Leaching of nitrates may pose a health hazard if they occur in food, particularly, leafy vegetables and drinking water.

climatology: study of climatic conditions, changes, effects, etc., that relate to the general weather conditions of a place.

cyclones: a cyclone is a violent storm in which air circulates rapidly in a clockwise direction.

economics: the study of the production of wealth and the consumption of the goods and services in a society, and the organisation of its money, industry and trade.

endotoxin: a toxin released by the degeneration or death (lysis) of bacterial cell.

epidemics: the occurrence of a disease which affects a very large number of people living in an area and which spreads quickly to other people.

extinct: a species of animals or plants which no longer has any living members.

geology: the scientific study of substances such as rocks and soil in order to find the origin, structure and history of the earth.

geomorphology: branch of science dealing with form and structure of earth.

Inter alia: among others

light quantum: light is supposed to be made up of small packets of energy called quantum (Pl. **quanta**)

limnology: branch of science dealing with fish biology.

national park: a national park is a large area of land which is protected by the Govt. because of its natural beauty, plants or animals and which the public can usually visit.

nitrification: the conversion by aerobic bacteria of organic nitrogen compounds into nitrates.

padyatra: journey on foot.

photovoltaic device: a device which uses photovoltaic cell for its source of energy. A photovoltaic cell generates electric current when exposed to radiant energy, sunlight. It is made up of packets of energy called photons. When these photons strike the surface of photosensitive material of the battery, some of these photons cause the electrons in the material to move around. Since flow of electrons is, by definition, an electric current, the cell acts as a source of electricity for the device.

satellite city: smaller city lying within the sphere of influence of a larger city, upon which it is socially and economically dependent. A satellite city often located beyond the ring of suburbs, is immediately continuous to the central city. Satellite cities are usually cities for such activities as manufacturing, trading, administration, education or recreation.

seismic activity: shock waves generated by any transient disturbance of the earth.

smokeless chulhas: hearths designed to achieve maximum efficiency of heat utilisation from burning of fuel wood.

sociology: study of human societies and of the relationships between groups in these societies.

stratification of atmosphere: the division into different layers of atmosphere, depending upon temperature.

taxonomy: classification and naming of things such as animals and plants in groups within a larger system according to their similarities and differences.