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VIDYASAGAR UNIVERSITY

DIRECTORATE OF DISTANCE EDUCATION

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M. A. / M. Sc. in Geography

PART - I

Paper : IV • Module No. : VII • Unit : 2, 3, 4 & 5
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DIRECTORATE OF DISTANCE EDUCATION
VIDYASAGAR UNIVERSITY, MIDNAPORE

M.A. / M. Sc. in
GEOGRAPHY

PART – I

PAPER – IV

MODULE – VII ★ UNIT – 02, 03, 04 & 05

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M.A./ M. Sc. PART – I

Paper – IV

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M.A./M.Sc. PART - I
Paper : IV Module : VII
Unit – 02

Structure of the Unit

- Land Reclamation, Alkaline Soil, Case Studies in Sundarban and East Kolkata;
- Acidic Soils of India, Problems and Reclamation;
- Mountain and Desert Soils of India, Problems and Reclamation

■ 4.7.2.0. INTRODUCTION :

Land reclamation and settlement, agricultural expansion along with mangrove felling and other forms of resource extraction have changed the wild landscape from the interior parts towards the shoreline in the rich alluvial soils of the delta and coastal plain in the previous centuries. The broad low-lying Sundarban area with one or two meter surface height from the sea level was extended over 18000-20000 km^2 in the lower part of Ganga delta in the historical past. Land use changes in the Lower Bengal for the past two centuries indicate a clear picture of wetland depletion. Extensive tidal spill basis of upper catchment of Matla-Bidyadhari distributary cannels around East Kolkata areas are largely depleted because of reconstruction of landuse changes with extensive built-up areas and arable lands in the latter half of the past century. The alkaline soils of the Sundarban wetlands and East Culcutta wetlands are reclaimed with enclosed embankments, rain water inundations or washing process and drainage control measures in the past.

■ 4.7.2.1. OBJECTIVES :

- To study on land reclamation methods of alkaline soil region of the Sundarban and East Kolkata for land use planning and management;
- To identify the Acid soil regions of India, their formation, problems and reclamation;
- To explain the characters of Mountain and Desert soils of India, their problems and Reclamation methods.

■ 4.7.2.2. LAND RECLAMATION : ALKALINE SOIL, CASE STUDIES IN SUNDARBAN AND EAST KOLKATA :

The world 'alkali' itself is of Arabic origin meaning ash-like, and was used for the surface soil which looked like calcined wood ash to the Arabs. Thus, the world came to be applied to salt-affected soils. Many common terms used in Russia, America and elsewhere are familiar in Indian soil literature and have been frequently employed to describe soils of this country. Solonchak, solonetz and solod are the Russian terms applied to genetic types of saline, alkali and degraded alkali soils, and express three stages in the evolution of salt-affected soils. In classifying such soils, Russian soil scientists combined the principles of pedology, geochemistry and plant physiology.

● **Alkali soils :** Alkali soils are the typical *usar* soils found in the state. The profile possesses a hard and compact structure with loam to clay-loam texture, the surface soil of which rests on heavier indurated and columnar subsoils. When wet, the soils are plastic and gummy. Physical deterioration of the soil is of an extreme degree. Usually, a thick and highly cemented bed of big-sized *kankar* is to be found in the subsoil which is occasionally so much cemented that it appears rock-like and difficult to pierce. Water percolation is almost nil and surface water stagnation with high degree of turbidity is a common land feature. On evaporation and drying, such condition may leave flakes of clay and black reddish-brown residue on the surface (black alkali) caused by the dissolution of humus in the alkaline media. The soils are completely barren or else can support on salt-tolerant grasses during the rainy season.

The above features infect depict the maximal stage of alkali development. Soils with various degrees of alkalization are commonly met with and one constituting the milder type, as reported by Agarwal and Yadav (1954) fro Kasimabad (Hardoi district), had the following profile characteristics :

0-22.5 cm	:	Brown loam; slightly friable, mildly calcareous,
225.-52.5 cm		highly alkaline.
52.5-82.5 cm		Dark brown; clay loam; semi-indurated; nodules of
82.5-180 cm		Lime deposited in the bottom.

The morphology of the profile clearly indicates that the soil is not highly sodiumized. Exchangeable sodium percentage is only a little above 15 but the salinity is low and below 4 mmhos/cm. numerous other examples are, however, encountered where alkalization is moderate to extremely high, particularly in the sub-soils. The surface soil may show saline-alkali nature due to capillary rise of soluble carbonates. Distinction between saline-alkali and alkali features in such soils is only a matter of convention; otherwise it has little practical significance.

Degraded alkali soils. Under this category may be included those saline-alkali soils with low lime content which have been partially reclaimed through paddy cultivation in eastern districts of Uttar Pradesh. The surface soil has undergone dealkalization with consequent development of moderate to slight acidity; but in the subsoil potential dangers of salinization or alkalization still persist or soluble sodium percentage is still high enough to inhibit root development of crops other than paddy. The typical morphological characters of solodization, as visualized by Russian workers, are not found in these soils; but chemically and physico-chemically they can be categorized with degraded alkali soils. In morphological make up they are somewhat akin to *dhankar* soils (Gupta *et al.,* 1957). The following profile is from village Shikarpur, district Azamgarh (Gupta, 1961).

0-15 cm	A clear thin horizon of rusty grey sandy loam; compact; non-calcareous, moderately acidic, some organic matter and roots of paddy.
15-42 cm	Dark grey with abundant rusty mottlings; loam; mildly acidic; compact; non-calcareous; transitional horizon.
42-152 cm	Dark grey changing to grayish-yellow clay loam; iron nodules and mottlings; blocky and compact; moderately alkaline; slightly calcareous; white specks of lime present.

The morphological features reflect a blocky, dense and compact subsoil. Chemical characterization reveals high exchangeable magnesium and an exchangeable sodium percentage greater than 15 with soluble sodium percentage about 90. The surface horizon is lighter in texture with acidic reaction and the whole profile shows the effects of water logging. The surface horizon has been built up in humus and nitrogen.

Degradation processes in alkali soils. The degradation processes in alkali soils have been studied in temperature countries by determining the amorphous silica soluble in 5 per cent KOH. A few alkali and degraded alkali soils, from Ghazipur and Azamgarh districts, were subjected to this treatment (Gupta, 1961). It may be observed that, although some free amorphous silica has accumulated at the surface of the alkali soils upon degradation, the disruption of the clay complex is not very conspicuous if judged from the accumulation of amorphous silica in the A-horizon.

Physical properties. Recent studies (Gupta and Narain, 1971) have revealed differences in physical properties like bulk density, porosity both aeration porosity and capillary porosity, hydraulic conductivity, intrinsic permeability, infiltration rate, available moisture capacity, particle size distribution in the clay range, and chemical and mineralogical composition etc., between saline and alkali soils and their normal counterparts.

The total porosity in the upper layers is 5-6 per cent less in saline-alkali soils but the aeration porosity is 50 per cent that of normal soils with the result that hydraulic conductivity and basic intake rate are practically reduced to 1/10 of the neighbouring good soils. Under more deteriorated conditions the differences are found to be still greater.

Pan formation. The saline-alkali soils of the Indo-Gangetic basin of Uttar Pradesh often possess a dense layer in the subsoil, of the nature of an indurated clay and/or *kankar* pan which restricts leaching and presents serious problems in the reclamation and management of these soils. Investigations done at the Usar Reclamation Farm, Chakeri, Kanpur have revealed the occurrence of a compact layer of 30-40 cm thickness and 30-40 cm below the surface, beyond which there is generally a zone of *kankar* ($CaCO_3$ concretions), often as a thick p . going up to 1.2 to 1.5 metres depth.

The compact layer possesses not only a higher clay content, but more than double the proportion of fine clay, higher bulk density and very low aeration porosity and hydraulic conductivity as compared to layers above and below it. ESP also rises to 84 in the compact layer. An interesting feature is the increase in the percentage of expanding lattice minerals in

the compact layer. Water-table fluctuates in this area between 1 and 2 metres during summer and winter.

Size of alkali land blocks. In any scheme of large-scale economic utilization of saline-alkali lands, it is most important to determine the extent and location of such tracts in the affected areas. Small and scattered patches can be treated through farmer's own efforts, if he is given requisite technical advice and financial assistance. Big stretches of problem prone lands which can form independent and manageable units for large-scale application of ameliorative and soil management treatments can come under cooperative projects for economic utilization of such lands. With this aim in view, a systematic survey of *usar* tracts in larger blocks, of over 80 ha each, was initiated by Agarwal and Yadav in five districts of Uttar Pradesh, where the intensity of the occurrence of such lands is highest and where about 50 per cent of the total alkali affected area in the state is encountered. In Table are given the result of such a survey in the five districts. From the data it can be observed that there are large numbers of big and extensive blocks of alkali-infested areas, that can be independently developed and, after adoption of suitable reclamation techniques, used for agricultural or other useful purposes. The location of these and smaller blocks in *Tehsil* Akbarpur in Kanpur district. This gives an idea of the distribution pattern of saline-alkali lands in the state. The total area surveyed in the above project was 0.1 million ha. It is estimated that another 0.12 million ha of alkali land exists in the state, mostly in compact blocks of over 80 ha each. These lands have been classified with Type 3 and Type 4 soils in the Soil Survey Reports of the State Agriculture Department.

The saline coastal alluvium of West Bengal. Banerjee (1959) reported some salt-affected soils of Canning, which show characteristic differences from the coastal salt-affected lands described above or those found inland in the arid region. To illustrate the points, the data of only two selected profiles have been in Table. The soils are saline and show high exchangeable sodium percentage, but the pH in all such cases in all such cases is not high and in a typical case is even moderately acidic. The salinity obviously must be due to neutral salts and the high acidity has been explained as coming from organic acids released from the large amounts of decaying organic matter present. This gives rise to degraded saline-alkali soils. Because of

these characters it was suggested that the reclamation of these soils would require measures different from those for salt-affected soils of arid region in the inlands.

Nature of salt-affected coastal soils of West Bengal *(Banerjee, 1959)*

Depth (cm)	CEC m.e. %	E.S.P.	pH	Soluble salt per cent
Saline-alkali (Canning)				
0-30	14.5	56.8	8.6	0.904
30-60	13.1	61.2	7.8	0.685
60-90	15.1	84.9	7.5	1.126
90-120	15.5	75.5	7.4	1.583
Degraded saline-alkali (Canning)				
0-30	11.2	19.6	4.9	0.512
30-60	11.8	22.3	5.1	0.551
60-90	13.8	26.8	5.3	0.701
90-120	12.6	15.9	5.2	0.817

▲ **Reclamation – Drainage and Leaching :** India, reclamation of saline and alkali soils was practiced much before any scientific knowledge on the nature and properties of these soils became actually available. Early attempts were based on trial and error methods with little or no knowledge of the basic principles involved in these processes of reclamation. Some of them which were successful, were, later on, proved to be technically sound. Some others turned out to be mere temporary expedients and the land reverted to the original condition sooner or later; and yet many others failed to show any improvement on the land so treated.

The methods to be adopted for reclamation have necessarily to be based upon a proper understanding of all the causative factors which lead to the development of the saline and alkali conditions in the soil. According to Kelley (1951) for any reclamation technique to be permanent, the following three essential requirements have to be met with :

i) salt or alkali must be completely removed from the root zone;

ii) the land must be prevented from reverting to the original conditions; and

iii) the repair of the damage, already done to the soil, should be substantial.

Harmful salts being soluble can be removed by leaching with water which is the chief vehicle of their transport, but in many cases the exchangeable sodium in the soil has to be

replaced by calcium, for which a calcareous amendment or some other technique may be necessary before the leaching process can be made effective. A prerequisite to these operations is drainage capacity of the land which must be restored to permit free percolation of water in the soil profile. If there is ingress of sea water, it should be checked by proper embankment or any other method. In situations where irrigation with saline water is the cause of salinity, such use will have to be stopped or modified suitably. Thus depending upon the local conditions, a combination of techniques is usually required to achieve a permanent solution of the salinity or alkali problem in soils. It is often observed that emphasis is laid on one or the other technique depending upon the soil and subsoil condition and the extent of deterioration involved, but the whole range of the problem is not tackled. In such attempts success may or may not be achieved, although there are certain saline and alkali soils which, by their very nature, are amenable to easy reclamation techniques thereby giving complacency to those not fully aware of the intricate problem of soil salinity.

A saline or an alkali soil in the process of reclamation passes through a number of stages which can be utilized to test or judge the nature of the reclamation methods under operation and the degree of their effectiveness. These are reflected on the stand of crops being grown on such lands and on the physical and chemical changes introduced in the soil characters. As the salt toxicity is lowered, the land passes from practically nil or patchy crop growth stage to one capable of almost a uniform crop stand. The soil tests can reveal if the last vestige of saline or alkali hazard has been removed from the entire root zone for normal crop growth. Although crop growth is usually regarded as a good index to judge the progress of reclamation, soil tests provide a more reliable and precise measure for such an appraisal. Temporary expedients can make shallow soil depths acquire temporarily the desirable properties for moderate to even good crop growth; but sub soils may continue to remain bad or even worse and may thereby present constant threat to crop production on such lands. This should not be taken to mean that such ameliorative methods are not worth any trial. In practice, these techniques have under certain situations shown some degree of success, but the cost and effort spent thereon will ultimately have to be balanced with the benefits that may accrue continually from the land over a number of years. In fact, what one should attempt is some type of permanent reclamation capable of sustaining worthwhile productive agriculture.

Economy and time involved are, moreover, additional factors that need to be considered in any scheme of reclamation of such soils. Some cheaper amendments are slower to react and start producing uneconomic returns but catch up later as cropping progresses. Further, certain ameliorating materials may be available as surplus farm commodity or industrial wastes or by-products in the region; but the same may prove either extremely expensive or be available with difficulty at other places. These factors have to be fully considered before appreciating any method or technique of reclamation of such soils. In practice also, the reclamation procedures for saline and alkali soils have to be properly judged in the light of the above considerations.

On basic principles, saline soils are generally reclaimed by establishing drainage and resorting to leaching operations with enough quantity of good quality irrigation water. Alkali soils would, in addition, require a suitable amendment for a ready source of soluble calcium to neutralize the alkali, replace the exchangeable sodium in the soil and flocculate the clay for improving permeability. Such a source of soluble calcium can be found in a number of ways, either by adding directly a soluble calcium compound like gypsum or calcium chloride, or using an acidifier, which may be inorganic or organic in nature, but capable of dissolving the existing reserves of native insoluble calcium in the soil and converting it into a soluble form for this purpose. These principles are elaborated in the discussion that follows.

■ 4.7.2.3. ACIDIC SOILS OF INDIA : PROBLEMS AND RECLAMATION :

Formation : Acid soils are formed under natural conditions as well as artificially by the continuous use of certain fertilizers. Soils developed in humid regions, e.g. cool temperate and moist tropical regions, are mostly acid. Under these conditions the alkali and alkaline earth bases that are liberated during weathering are leaching out leaving the soil deficient in bases. When all the soluble bases are lost, the H ions of the carbonic and other acid developed in the soil replace the basic captions of the colloidal complex. As the soil gets gradually depleted of its exchangeable bases through constant leaching, it gets desaturated and becomes increasingly acid. Various podsols, brown earths, laterites and other latosolic soils are all acid soils. Acid soils are also produced through the accumulation of organic residues. The decomposition of organic matter in the absence of oxygen gives rise to a product called peat which is acid in reaction. The acidity of peat and other swampy soils is mainly due to the accumulation of humic acids.

The continuous use of physiologically acid fertilizers on soils that are poor in lime also leads to the development of acid soils. When nitrogenous fertilizers of ammoniacal nature like ammonium sulphate, ammonium chloride, etc. are added to soil they are nitrified, and nitric acid is liberated. The acid so developed reacts with calcium and other bases to form calcium and other nitrates. Being soluble, they are either removed by crop or lost in drainage. At the same time, a part of the NH_4^+ ions are absorbed by the soil colloidal material. The ammonium ions so adsorbed replace calcium and other metallic cations, which are lost in drainage if not absorbed by crop. The ammonium ions of the colloidal material get nitrified and form nitric acid. The residual anions give rise to acids like sulphuric and hydrochloric which further deplete the soil solution and the colloidal complex of their bases. On both these accounts, the clay gets desaturated, H ion concentration increases and the soil pH is lowered. Other nitrogenous fertilizers like urea, oilcakes, etc. which release ammonia on decomposition also increase soil acidity.

Soil pH preference of crop plants

Crop	Botanical name	pH range
Cereals :		
Barley	*Hordeum sativum*	6.5-8.2
Oats	*Avena sativa*	4.8-7.5
Rice	*Oryza sativa*	5.5-6.5
Wheat	*Triticum vulgare*	5.5-8.0
Millets :		
Italian millet	*Sataria italica*	5.0-7.0
Maize	*Zea mays*	5.5-8.0
Sorghum	*Sorghum vulgare*	5.5-7.5

Crop	Botanical name	pH range
Oilseeds :		
Coconut	*Cocos nucifera*	6.0-7.5
Groundnut	*Arachis hypogaea*	5.3-7.0
Linseed	*Linium usitatissimum*	5.0-7.0
Rape	*Brassica napus*	6.0-8.0
Soybean	*Glycine Max*	6.0-7.5

Fibre crops :		
Cotton	*Gossypium spp.*	5.0-6.5
Sugar crops :		
Sugarcane	*Saccharum officinarum*	6.0-8.0
Fodder crops :		
Bermuda grass	*Cynodon dactylon*	6.0-7.5
Berseem	*Trifolium alexandrinum*	6.5-8.5
Johnson grass	*Sorghum halepense*	5.0-6.0
Lucerne	*Medicago sativa*	6.2-8.2
Sudan grass	*Sorghum sundanense*	5.0-6.5
Sunflower	*Helianthus annuus*	6.0-8.0
Vegetables :		
Cabbage	*Brassica oleracea*	5.5-7.5
Cowpea	*Vigna sinensis*	5.0-7.0
French bean	*Phaseolus vulgaris*	6.0-8.0
Lime bean	*Phaseolus limensis*	6.0-8.0
Onion	*Allium cepa*	6.0-8.0
Pea (garden)	*Pisum sativum*	6.5-7.5
Potato	*Solanum tuberosum*	4.5-6.5
Sweet potato	*Ipomoea batatas*	5.8-6.0
Tomato	*Lycopersicum esculentum*	5.5-7.0
Turnip	*Brassica rapa*	5.5-7.0
Velvet bean	*Stizolobium deeringianum*	5.5-7.0
Fruit crops :		
Banana	*Musa spp.*	6.0-7.5
Pineapple	*Ananas sativa*	5.0-6.5
Plantation crops :		
Coffee	*Coffea arabica*	4.5-7.0
Rubber	*Hevea braziliensis*	3.5-6.0
Tea	*Thea sinensis*	4.0-5.5
Narcotics :		
Indian hemp	*Cannabis sativa*	6.0-7.5
Tobacco	*Nicotiana tabacum*	5.0-5.6

The use of materials like sulphur, molasses etc. which liberate acids during the course of their decomposition also encourages the loss of lime and other bases from the soil and thus increases soil acidity. If the soil is poor in lime it gets acid quickly. As the acidity of a soil increases, crop production declines. The poor growth of crop is not due to the injurious effects of hydrogen ions but to secondary effects, more especially to the lack of calcium and some of the other essential plant nutrients in available form as explained earlier. It may also be due to the suppression of bacterial activity such as nitrification etc.

- **Acid Sulphate Soils** : Develop as a result of the drainage of a parent material that is rich in pyrite, FeS_2. Pyrite accumulates in waterlogged soils that are both rich in organic matter and flushed by dissolved sulphate, usually from sea water. When drainage brings oxygen into these previously waterlogged soils, pyrite is oxidized to sulphuric acid and acid sulphate soils are formed where the production of acid exceeds the neutralizing capacity of the parent material, so that the pH falls to less than 4.

In recent coastal plains and inter-tidal swamps, there are an estimated 12 million ha, mostly in the tropics, in which the topsoil will become severely acid or has already done so as a result of land reclamation. There is probably a much greater area of potentially acid material covered by a shallow layer of *non-acid peat* or *alluvium*. Inland, acid sulphate soils have developed naturally as a result of changes in hydrology or relative sea level. Acid sulphate soils occur by and large in parts of Kerala, in the south-east coast of Tamil Nadu, Indian Sunderbans falling in certain part of West Bengal and mangrove areas of Andaman Islands.

Acid Sulphate soils are an almost unique case where the soil problems are so severe that they can dominate most other aspects of land development : from engineering works (including the kind of concrete required, design of roads, embankments and drainage systems) to agricultural systems (including the choice of crops, disease, lime and fertilizer requirements).

Potential acid sulphate soils are not acid but will become acid if they are drainaged. Typically, they are unripe, saline, and give off a strong smell of hydrogen sulphide when disturbed. Mineral soils are very dark grey and rich in organic matter. They do not contain abundant shell or other carbonates.

A soil or sediment containing pyrite only becomes a potential acid sulphate soil when the potential acidity, represented by the pyrite, exceeds the soil's neutralizing capacity. The most significant source of neutralizing capacity is calcium carbonate. One part by mass of pyrite sulphur is neutralized by three parts of calcium carbonate. Carbonate contents of shallow-water marine and brackish-water sediments range from negligible in the humid tropics up to 15 per cent or more in the arid and temperate zones. In tropical and sub-tropical environments, the conditions for carbonate accumulation appear to be mutually exclusive.

Saline and brackish-water tidal swamp and marsh constitute by far the most extensive potential acid sulphate environment. The dense vegetation favours the process of pyrite formation, the tidal cycle brings in sediment, renews the supply of dissolved sulphate, and removes soluble by-products. However, within this landscape there are important differences in potential acidity and other soil characteristics that affect the prospects for land reclamation of development.

The reaction of pyrite with oxygen is a slow process, but pyrite is rapidly oxidized by iron III is solution. Iron III is thereby reduced to iron II, but iron III is regenerated from iron II by the bacteria *Thiobacillus ferrooxidans*. This catalytic oxidation of pyrite can take place only at pH less than 4, because iron III is soluble only under these very acid conditions. Possibly another group of sulphur-oxidising bacteria may be involved in the initial acidification of the system.

Overall, the oxidation of pyrite can be represented by the equation :

FeS_2	+	$^{15}/_4 O_2$ +	$^7/_2 H_2O$ —>	$Fe(OH)_3$	+	$2SO_4^{2-}$ +	$4H^+$
Solid pyrite Dissolved		Oxygen		Colloidal iron III		Sulphuric acid	

Most of the iron III ultimately crystallizes as the reddish brown oxide goethite in mottles, coatings and nodules within the soil. Some iron II may be lost from the soil in drainage waters and will precipitate under more oxidizing conditions in drains and ditches which can even be blocked by gelatinous deposits of hydrated iron III oxides.

The severe acidity of acid sulphate soils is responsible for accelerated acid weathering of aluminosilicate minerals and the increased solubility of aluminium. Aluminium is insoluble at pH values above 4, but is increasingly soluble at lower pH values.

The acid sulphate soils in addition to having pH value less than 4 under aerobic condition is associated with yellow mottles or coatings *of jarosite and deposition of ochre in the soil or in drainage waters*. In flooded soils, for example in paddy fields, the pH will rise above 4 because of soil reduction, but a sample of an acid sulphate soil allowed to dry will become severely acid again. Sometimes, usually in poorly drained soils, jarosite cannot be seen even *under severely acid conditions*.

Acid sulphate conditions occur in sand, peat, and clay, although acid sulphate clays are most extensive. Clay and peat soils that have become acid as a result of recent land drainage typically remain unripe, or under-consolidated. Unripe soils have a very high water content, so they are soft and can be squeezed between the fingers. Drainage eventually brings about soil ripening, which entails an irreversible loss of water, but the process in inhibited by severe acidity because roots are unable to enter the acid layer to extract the excess water. As a result, acid sulphate soils remain poorly drained and often saline.

Major Soils of India and their equivalent in US Soil Taxonomy and FAO Legend

Genetic Classification	US Soil Taxomony	FAO Legend
Alluvial Soil	Inceptisols, Entisols, Alfisols, Aridisol	Cambisols, Fluvisols, Luvisols, Gleysols, Solonchaks, Solonetz
Black Soils (Regur)	Vertisols, Inceptisols, Entisols	Vertisols, Cambisols, Leptosols, Regosols,
Red Soils	Alfisols, Inceptisols, Entisols	Luvisols, Cambisols, Leptosols, Lixisols, Nitisols
Laterite and Lateritic Soils	Oxisols, Ultisols, Inceptisols	Cambisols, Alfisols, Leptosols, Plinthosols,
Saline and Alkali Soils	Aridisols, Inceptisols, Alfisols, Entisols, Vertisols	Solonchaks, Solonetz, Cambisols, Luvisols, Vertisols, Arenosols
Desert Soils	Aridisols, Entisols	Cambisols, Leptosols, Calcisols, Arenosols, Fluvisols
Forest and Hill Soils	Inceptisols, Alfisols, Mollisols, Ultisols, Entisols	Cambisols, Luvisols, Leptosols, Phaeozems
Peaty and Marshy Soils	Histosols, Inceptisols, Entisols	Gleysols, Cambisols, Fluvisols

Old acid sulphate clays that have ripened naturally typical have a very dark-coloured toposoil, a prominently mottled subsoil with reddish-brown mottles and nodules of iron oxide, and yellow jarosite mottles at greater depth.

Distribution of Soils of India

Order	Area (in mha)	Per cent
Alfisols	79.7	24.25
Entisols	80.1	24.37
Inceptisols	95.8	29.13
Vertisols	26.3	8.02
Aridisols	14.6	4.47
Mollisols	8.0	2.43
Ultisols	0.8	0.26
Oxisols	0.1	0.03
Histosols	–	—
Non Classified (uncultivable land)	23.1	7.04
Total :	**328.5**	**100.0**

▲ **Amelioration :** Slightly acid soils are quite suitable for growing crops without any treatment, but those that are strongly or even moderately acid do not allow the normal growth of plants. In such cases it is necessary to neutralize their acidity before crops can be grown successfully. The application of substances containing calcium and magnesium such as time limestones dolomite, etc. is the common procedure for the improvement of these soils. The lack of exchangeable bases, especially exchangeable calcium and magnesium, is the main cause of their unproductiveness. By adding suitable quantities of some of the compounds mentioned above it is possible to restore the exchangeable bases in the colloidal complex and to correct other soil conditions that are associated with acid reaction.

For obvious reasons gypsum and calcium chloride cannot be used for improving acid soils. When the calcium ions of these salts replace the hydrogen ions of acid clay, they liberate strong acids, e.g. sulphuric or hydrochloric acid, which actually reduces the pH of the soil solution and makes the soil more acid. These substances, are therefore, not suitable as liming materials.

▲ **Changes involved :** the compounds found most suitable for correcting soil acidity are lime (CaO), hydrated or slaked lime $(CaOH)_2$, ground limestone ($CaCO_3$), and dolomite or dolomitic limestone [$CaMg(CO_3)_2$]. Though they are different in chemical composition their behaviour is more less the same, and hence they are all known by the more general term lime. Whatever the substance used, it first undergoes solution under the influence of CO_2 present in soil air. The reactions involved may be expressed as under :

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

$$Ca(OH)_2 + 2\ CO_2 \longrightarrow Ca(HCO_3)_2$$

$$CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$$

$$CaMg(CO_3)_2 + 2\ H_2O + 2\ CO_2 \longrightarrow Ca(HCO_3)_2 + Mg(HCO_3)_2$$

As the concentration of CO_2 in soil air is quite high, all these compounds are converted in soluble bicarbonates which then react with the soil colloids. The reaction with calcium bicarbonate may be represented as follows :

$$H_2\text{–clay} + Ca(HCO_3)_2 \longrightarrow \text{Ca-clay} + 2\ H_2CO_3$$

The carbonic acid further reacts with lime and the series of changes repeats itself. The H ions of the acid clay are thus gradually replaced by the metallic Ca and Mg ions till the whole of the colloidal clay is turned into Ca-clay. The adsorption of the metallic cations thus increases the base saturation of the colloidal complex which ultimately leads to increase in pH of the soil solution. It is possible that some of the metallic cations may also be adsorbed by colloidal clay directly from the insoluble lime particles. In either case, the H-clay is converted into Ca-clay.

Under field conditions, probably the adsorption of basic ions from soil solution as well as from insoluble lime particles takes place simultaneously.

As the reactions between the colloidal complex and the lime compounds is reversible, a part of the adsorbed base may be brought into soil solution by the H ions of the carbonic acid. If for any reason, the concentration of H ions increases considerably, substantial quantities of Ca ions may be brought into soil solution and removed by leaching, erosion or crop-uptake.

The soil again becomes acid and it is then necessary to apply lime once again. In normal practice, the lime content of the soil, both total and exchangeable, is not allowed to be depleted to this extent. Additional quantities of lime are added from time to time in order to maintain the soil reaction neutral as long as possible. Many years of regular liming are often required to reach a state of near permanency.

▲ **Lime requirement :** The quantity of lime required to be added to a soil also known as its lime requirement, depends, among other factors, on its initial pH, base unsaturation and buffer capacity. The lower the pH, the greater the quantity of lime required. Similarly the greater the buffer capacity, the greater the lime requirement. The type of crop to be grown is another important factor to be considered in deciding how much lime to apply for the reasons we have already discussed.

Several methods have been proposed for determining lime requirement. According to one method, a known weight of soil is mixed with varying quantities of a standard calcium hydroxide or barium hydroxide solution in a number of flasks. Upto the equilibrium is established, the pH value of the suspension is determined electrometrically in each case. Titration curves are drawn from the data so obtained, and the quantity of lime needed to produce any particular pH is calculated from the curve. Usually pH 6.5 or 7.0 is taken to represent the desired pH for most crops. The figure so obtained multiplied by the liming factor gives the actual lime requirement.

▲ **Effect of lime on acid soils :** The main effect of lime on acid soils is to improve its chemical and biological properties. It has no effect on its physical condition for the reasons

previously explained. The structure and other physical features of acid soils are not improved by the addition of lime. It is possible that it exerts an indirect effect by encouraging the decomposition of organic matter and consequent greater production of organic colloids. The Ca-humus so produced is believed to be a more effective cementing agent in binding the soil particles.

Among the principal chemical properties affected by lime may be mentioned the reduction of hydrogen ions in the colloidal complex. It increases the availability of almost all the plant nutrients such as nitrogen, phosphorus, potassium, calcium, magnesiu, boron, zinc, copper and molybdenum and reduces the toxicity caused by soluble iron, aluminium and manganese.

One of the outstanding biological effects of lime is to encourage the microbial activity of the soil. By raising the soil pH it makes the medium more congenial for a number of micro-organisms. Nitrifying and nitrogen fixing bacteria, both symbotic and non-symbiotic, are stimulated by the addition of lime to an acid soil. Lime also brings about a more rapid decomposition of organic matter, both native and added as a result of increased microbial activity. This further increases the availability of nitrogen, phosphorus and sulphur.

On the other hand, lime may have adverse effect especially if the soil is over limed. If lime is added to an acid soil until the pH goes above 7.0 it produces certain deleterious effects on the crop. The harmful effect is more pronounced on soils that are not well buffered such as sandy soils and soils poor in organic matter. The main effect of overliming is to reduce the availability of some essential nutrients, both major and minor, such as iron, manganese, boron, copper, zinc, phosphorus, potassium, etc. and thus bring about nutrition deficiencies. Excess lime also interferes with the absorption of certain elements like potassium, phosphorus, boron etc. by plants thus hindering their utilization. The very rapid decomposition of organic matter in soils of arid and semi-arid regions is also attributed to the accumulation of excess lime in these soils. In reducing the acidity of strongly acid soils it is advisable to apply moderate quantities of lime at a time so as to raise the pH gradually rather than to make a heavy application one time.

■ 4.7.2.4. MOUNTAIN AND DESERT SOILOF INDIA. PROBLEMS AND RECLAMATION :

▲ **Desert Soils :** A large part of the arid region, belonging to western Rajasthan, southern Haryana and SW Punjab lying between the Indus river and the Aravalli hills, covering an area of 29 million ha (290,000 km^2) have desert conditions of geologically recent origin. It is different from other deserts in having distinct summer monsoon rains. The area receives low rainfall (<500 mm) against high potential evapotranspiration (1,600 to 2,060 mm). A major part of the region consists of sand dunes and undulating sandy plains. The sands are derived from the disintegration of subjacent rocks, but are largely blown in from the coastal regions and the Indus Valley.

Potentially such areas are as fertile as the alluvial soils, but, because of the climate limitation of dryness, these have been lying utilized. Further owing to the wind action, the dry sand starts moving in the direction of the wind and poses a threat to the adjacent cultivated areas by depositing a thick mantle of sand at the surface. The sands in conjunction with the arid climatic conditions result in poor soil profile development. The mineral composition of the desert sand is quartz (as rounded grains); in addition, feldspar, hornblende and calcite grains, in fair proportions are observed.

Studies on soil genesis and classification of desert soils are few. This is partly because of rather weak pedogenic manifestation in comparison with other soil groups, and partly because of the difficulty in ascertaining the pedogenic changes that have taken place owing to erosion hazard and/or variations inherent in parent material.

▲ *Soil Characteristics*

- The soils are fine sandy to loamy fine sand in texture with the percentage of clay varying from 3.5 to 10.0
- They are pale brown to yellowish-brown in colour, and structure less to weak sub angular blocky in structure.
- They are generally poor in nutrient and water-holding capacity.

— They have the tendency to disperse on account of sodium-clay formations in the sub soils which may render them less permeable and may retain more moisture.

— Where moisture is not deficient, the presence of phosphates together with nitrates goes a long way to make these desert sands fertile for growing selected crops.

— The pH of these soils varies from 7.2 to 9.2; generally between 8.1 to 8.6 because of these calcareous natures.

— The salts are generally high but are not toxic in amount.

— The soils generally have redistributed alkaline earth carbonates from 10 to 70%; in sizeable area the soils have strongly lime-indurated zone at shallow depths. The formation of these calcitic accumulations in pedogenic (Sehgal and Stoops, 1972).

▲ *Classification*

The calcareous desertic soils of Punjab and Haryana were classified as *Pedocal Sierozems* or calcareous sierozems. The soils of Rajasthan in the 300 to 500 mm rainfall zone are classified as Grey Brown (Desert) and of drier region as Desert Soils.

These soils were earlier classified as Regosols within the Order : Azonal. In the new US Comprehensive System, they qualify for the Orders and (Suborder) as :

— Aridisol (Orthids) and

— Entisol (Psamments)

▲ Forest and Hill Soils :

The total forest area in India is estimated at 55 million hectares which constitutes 18% of the total geographical area. The major forest areas are covered by tropical deciduous, coniferous and tropical evergreen forests and occur in Himachal Pradesh, Jammu & Kashmir, Uttar Pradesh, Nagaland, Assam, Meghalaya, Orissa, Arunachal Pradesh, Madhya Pradesh, Mizoram and Manipur. While the climatic condition and altitude control the kind of forest species growing in different areas, the kind of vegetation and topography control the soil profile

development. The major soils, as observed in different forest areas are : Brown Forest and Podzolic (in the Himalayas) and Red and Lateritic soils (in the Deccan Plateau). The Himalaya soils are formed under cool/cold humid condition and on sedimentary, igneous or metamorphic rocks. The Deccan Plateau soils are formed from igneous and metamorphic rocks under tropical conditions. Some important soils are discussed are under :

▲ Podzolic Soils :

The soils formed under coniferous vegetation in the presence of acid humus and low base-status are Podzolic in nature. Owing to leaching of bases and translocation of sesquioxides, the soils developed under coniferous vegetation (especially deodar) do show characteristics associated with podzolization. But since the parent materials are not favourable and the breaking down of soil mineral particles in the unsaturated organic acid is absent, the process of podzolization, as operative in the Himalayas, is restricted to the mobilization of sesquioxides. The distinguishes the podzolic soils of the Himalayas from the true podzols observed in Europe. Although some workers have reported the presence of podzols on the plea that the soils of humid zone (Dalhousie, Simla, Manalai areas in Himachal Pradesh) show the accumulation of organic matter and amorphous Al and Fe in their B-horizons, yet the reported data do not meet the requirements of true Podzol (Spodosol), as laid down in Soil Taxonomy.

▲ Characteristics

The podzolic soils are characterized by :

— moderate (to strong) acidity with pH varying from 5.0 to 6.0.

— high organic matter (2-3.5%), and moderately high (20-30%) clay content.

— Variable exchange capacity (generally 10-25 me/100g soil) with low base saturation (generally <50% which may reach <35 in the lower horizons as in some soils of H.P. and Nagaland.

— Deficiency in phosphorous resulting from the formation of iron and aluminium phosphates.

▲ ***Classification***

Broadly speaking, the soils developed under *Pinus roxburghii* qualify as Alfisols; the soils under *Cedrus deodara,* and health vegetation as Ultisols (on flat plateau and in Valleys) and Inceptisols (on slopes).

▲ Brown Forest Soils :

The other soil formations in the forest areas developed on sand-stone, limestone, or colluvium, under sub humid (to humid) climatic environments and Pinus and/or mixed vegetation are Brown Forest Soils. These soils occur in association with podzolic group of soils.

▲ ***Major Characteristics :*** The soils have :

— neutral to slightly-acidic reaction with pH generally varying from 6 to 7; the soils developed on calcareous sand-stones, however, show pH up to 8.0.

— moderate to high accumulation of humus at their surfaces with organic matter content varying from 1 to 3 per cent.

— Moderate cation exchange capacity (15-25 me/100 gm soil) with exchange complex almost saturated with bases (70-90%).

— High biological activity.

▲ ***Classification***

In view of their special characteristics, these soils with stable surfaces qualify for Inceptisol, or Mollisol and those on eroded surfaces or on slopes as Entisol.

Bakr *et al.* (1978) observed the occurrence of Inceptisols and Mollisols on southern aspects and Alfisols and Mollisols (with an argillic horizon) on northern aspects. They attributed the different soil formation to the influence of topography, especially the slope aspect.

■ 4.7.2.5. Self Assessment Questions

1. Discuss the land reclamation methods practiced in the region of alkaline soils with special reference to the Sundarban.
2. Explain how the alkaline soils of East Kolkata are reclaimed for land use planning and management.
3. Identify the formation and characteristics of acid soils of India. Discuss their problems and reclamation methods for land use planning and management.
4. Explain the characters of Mountain and Desert soils of India Identify their problems and reclamation for land use planning and management.

■ 4.7.2.6. References

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■ 7.3.0 INTRODUCTION

The governments in most of the countries exert direct or indirect influence on land use. One of the fundamental causes of government intervention in land use is that individual and societal utility does not always coincide. The relation between individual and societal utility and objectives is therefore fundamental to the whole question of government influence on land use. The nature of this influence varies from country to country and the influence of government is contemporary as well as historical.

Wetland is considered to be the most important component of ecosystem, which is currently under threat due to the transformation of land use. Today, much more emphasis is being placed for the conservation of wetlands at the government level.

Increasing urbanisation and industrialisation as well as extraction of minerals at excessive rate are responsible for landscape ecological conversion thereby contributes to numerous environmental problems. Diverse measures can be adopted to combat these problems so as to minimise the harmful effects on environment.

Wastelands should be used for productive purposes through appropriate management practices. National Wastelands Development Board, Society for Promotion of Wastelands Development, NRSA and some other organisations have done commendable work in this direction.

■ 7.3.1 OBJECTIVES

After studying this Unit, you should be able to:

- Understand the government control on land use in different countries;
- Describe the policy measures for the conservation and management of wetland, urban land, industrial and mining lands and river valley;
- Explain the meaning of wastelands and role of National Wasteland Development Board in the management of wastelands in India.

■ 7.3.2 KEY WORDS

Ownership: Individual's right on land holdings

Occupancy: This describes the action or fact of occupying a place by individual or community.

Land Reform: In narrow and traditional sense, this is the re-distribution of property rights in land for the benefit of small farmers and agricultural labourers.

Policy: This is the course or principle of action adopted or proposed by national body and/or international organisation.

Wetland: It describes an area of land which is often covered by water or which is swampy and marshy.

Wasteland: It describes an area of land which is barren and no longer usable for agriculture or for any other purpose.

■ 7.3.3 OWNERSHIP, OCCUPANCY AND GOVERNMENT CONTROL ON LAND USE

In most of the countries, the governments exert direct or indirect influence on land use. Although land may be considered as a commodity, it has also certain characteristics of common property resources like water or the atmosphere. The extent to which land is regarded as private or common property obviously varies, depending on the political outlook of the government. However, there are usually at least some restraints on private property rights in land even where right-wing governments hold sway.

One of the fundamental reasons for government intervention in land use is that individual and societal utility does not always coincide. The type of land use or land management that is optimal for the individual or company is not necessarily optimal for the community or society in general. The relation between individual and societal utility and objectives is therefore fundamental to the whole question of government influence on land use.

The nature of this influence varies from country to country. Further, the influence of government is contemporary as well as historical. Many western countries maintain controls, with varying degrees of stringency, on the ownership and occupancy of land. In some instances, these controls are legacies of old policies that were perhaps more relevant in the past than at present. But in other cases they are maintained because of a firm belief that certain types of occupancy are related to efficient land use and other types are undesirable (Mather, 1986).

■ 7.3.3.1 Western Countries Perspective

United States: In the United States, both federal and state regulations apply to land ownership by aliens and corporations (Harris, 1980; Morrison and Krause, 1975). Federal regulations have fairly minor effects, but seven states prohibit alien ownership within their borders and several others impose various forms of restrictions. Restrictions on corporate ownership are clearly intended to protect family farming

from competition by farming corporations or agribusiness. It is noticeable that corporations are permitted in some states to engage in forestry, which is strictly defined in legal terms.

Canada: Restrictions also exist in Canada. Controls on the scale of land to aliens were imposed in Prince Edward Island as early as 1859 (Brown, 1975). During 1970s, no fewer than seven provinces enacted legislation directed wholly or partly against absentee or foreign ownership of farmland (Troughton, 1981). For example, the Saskatchewan Farm Ownership Act of 1974 is aimed at ensuring that agricultural resources are controlled by resident, full-time farmers. Non-resident may be prohibited from owning more than a quarter section (65 ha) (Bray *et al.*, 1979).

Denmark: In Denmark, the range of persons eligible to buy agricultural land is restricted in order to control land speculation (Fløystrup-Jensen and Dyreborg-Carlsen, 1981). Regulations are aimed at ensuring that farms are purchased only by those whose main occupation is farming, and who will live on their farms. In this country, since the late 1950s, companies have been completely excluded from taking over agricultural land.

Norway: In Norway, agricultural land can be purchased only by persons with qualifications in agriculture, and even then only if in possession of a government permit. Several governments also possess powers to ensure that land is not misused or underused.

France and West Germany: In France and in parts of West Germany, provisions exist to require the owner or occupier of unused but previously cultivated land to bring it back into cultivation. If he declines to do so, he may be required to lease the land to someone who is prepared to use it more fully (Carty, 1978).

Britain: Britain is rather unusual in its laxity of government control on land ownership and occupancy. There are at present no restrictions on the ownership of land, although aliens were not allowed to own land in England until 1878. The foundation of direct control of land use in Britain is the town and Country Planning Act of 1947, which introduced the idea of 'development control'. Local government, usually operating within broad guidelines from central government, exercises development control by granting or refusing planning permission for proposed changes in the use of land. One of the main effects of the planning system in Britain has been to control the transfer of agricultural land to residential or other urban uses.

North America: The rate of urbanisation of farmland in North America, where planning controls of this type are generally weaker, has been maintained at high levels during the post-war period. In North America, urban zoning ordinances were introduced in New York City in 1916. By 1926, zoning had

spread to over 420 American cities, representing more than half the urban population. (Nelson, 1977; Platt, 1976).

■ 7.3.3.2 Indian Scenario

In India, land reform policy is formulated by enacting and implementing laws relating to ownership and occupation of land for economic prosperity from agricultural sector which is the backbone Indian economy. Thus land reform policy was translated into the following programmes of action such as (i) the abolition of prevalent intermediary system between the state and the tiller of the soil; (ii) the conferment of ownership rights on the cultivating tenants in the land held under their possession; (iii) imposition of a ceiling on agricultural land holdings as a measure contributing to the modernisation of agriculture and to eliminate parasitic absentee landlordism; (iv) rationalisation of the record of rights in land so as to reflect the rights of tenants, share-croppers and other categories of insecure landholders; and (v) consolidation of holdings with a view to making easier the application of modern techniques of agriculture (Planning Commission; Bansil, 1981).

Finally, it may strictly be pointed out that the ultimate aim of land reforms is the abolition of intermediaries, bringing the actual cultivator in direct contact with the state, democratisation of the rural social order for rational distribution of agricultural income and higher agricultural productivity which can provide maximum benefit to the society (De and Jana, 1997).

In general terms, controls are stricter in densely populated countries than in those with more favourable man-land ratios, but an important trend during the twentieth century, and especially during the last thirty years, has been for controls to be strengthened and extended almost worldwide (Ervin and Fitch, 1979). The extent of strengthening varies from country to country, but in many parts of the world it has been one of the most significant trends in land use in recent decades.

■ 7.3.4 POLICY REGARDING WETLAND, URBAN LAND, RIVER VALLEY PLANNING, INDUSTRIAL AND MINING

■ 7.3.4.1 Wetland

▲ 7.3.4.1.1 Objectives of Wetland Management

The main objectives of wetland management are environmental protection, production of renewable resources as well as recreation and aesthetics. Twelve specific objectives of wetland management are listed by Stearns (1978) as : (1) maintenance of water quality, (2) protection from floods, (3) to reduce erosion, (4) to provide a natural system for the processing of airborne pollutants, (5) to provide a buffer

between urban residential and industrial segments for ameliorating physical and climatic impact e.g. noise, (6) maintenance of a gene pool of marsh plants as well as to provide examples of complete natural communities, (7) creation of wildlife, (8) production of food, fodder and fibre, (9) to provide habitats for fish spawning and other organisms, (10) to control insect populations, (11) to provide aesthetic and psychological support for human beings and (12) to expedite scientific investigation.

▲ 7.3.4.1.2 Management Measures

It may be pointed out that the management of wetlands needs positive manipulation of the environment. Different manipulative measures for the protection of wetland are as follows:

I. ***Creation of Wetland:*** Creation of wetland in formerly dry and non vegetative areas is an important management measure against the trend of diminishing wetland resources as well as to provide aesthetic and functional units to the landscape. Wetland creation must include freshwater wetlands, building of farm pond, new creation of extensive inland and coastal wetlands.

II. ***Management of Water Quality:*** Wetlands can serve as the sinks of nutrients for many years but their assimilation capacity may be reached to a saturation point for certain chemical constituents (Kadlec and Kadlec, 1979 and Richardson, 1985). Some guidelines regarding the use of wetland for waste water regarding the use of wetlands for water treatment management have been developed by the individuals and agencies viz. Hammer and Kadlec (1983), U.S. Environmental Protection Agency (1983); WAPORA (1983), U.S. Environmental Protection Agency and U.S. Fish & Wildlife Service (1984) CTA Environmental Inc. (1985).

According to Hammer and Kadlec (1983) the design of wetlands for receiving and treating wastewater is controlled mainly by (1) the hydrologic conditions including the original water budget, time or retention, topographical character of the concerned wetland and the amount of received wastewater and (2) the dominant pollutant consumption processes including soil physical processes, microbial processes, biomass production, sedimentation and harvesting of vegetation.

The U.S. Environmental Protection Agency (1983) provided a number of critical technical and institutional considerations which independently or jointly may influence the feasibility in using wetlands as an alternative for wastewater management are given below:

A. Technical considerations include (1) Other values of the wetlands (e.g. wildlife habitat) should be considered, (2) Acceptable pollutant and hydrological loadings must be determined for the use of wetlands in wastewater management, (3) All existing wetland characteristics i.e. geomorphology, hydrology, water quality and vegetation should properly be understood, (4) Site specific analyses of

wetlands whether hydrologically open or isolated are essential to determine their potentiality for wastewater management. Hydrologically open wetlands are more likely to affect down- stream systems whereas hydrologically isolated wetlands are likely to be altered if wastewater is applied to them.

B. *Institutional consideration include:* 1) Potential conflicts between state agencies, federal agencies and local groups concerning the use of protection of wetlands.

2) Wastewater disposal into wetlands can often serve the dual purposes of both wetland protection and use.

3) Sometimes the State and municipal governments may be sufficiently responsible for the damages of private wetlands from wastewater disposal. So, ownership or legal control over wetlands particularly used for wastewater management is necessary.

4) Federal permitting processes do not recognize wetland disposal systems. Modification of existing requirements for permits to essential for making use of this effective method of wetland and management of wastewater.

III. ***Flood Control and Recharge:*** Hydrologic functions include water supply potential, ground water recharge, streamflow augmentation and flood potection. According to Verry and Boelter (1979) and Carter et al. (1979) wetlands do not always contribute necessarily to low flows or groundwater recharge. Consequently, some wetlands should urgently be protected for their ability for holding water as well as its slow return to the surface and ground water systems in the period of low water. It may be pointed out that if the wetlands are impounded to retain more water from the flooding downstream areas, there will be a considerable change in vegetation as the systems adapt to the new hydrological conditions.

IV. ***Agriculture:*** one of the management measures of wetlands is the practice of agriculture on it. For example, in New England the high salt marshes were harvested for "Salt marsh hay", an excellent bedding and fodder for cattle. Later on, these marshes were ditched to allow intrusion of tides to augment the growth of salt-marsh hay. In the sundarban areas of India also the salt-marshes are now being used for agriculture.

V. ***Aquaculture:*** Usually aquaculture needs more extensive manipulation of the environment than agriculture. Ponds with retaining walls or levees and pumps have little resemblance to the natural ecosystem. Estuarine wetland in a more or less natural state is used for raising fish. Fine mesh fences allow water ingress but still retain the cultured animals.

In the southern part of the United States a number of commercial ventures were launched in the 1970's. One of such commercial ventures is crayfish farming along with timber production. Their

living place is the burrows in shallow flooded areas such as swamp forests and rice fields. Crayfish remains in their newly constructing burrows until the next year flood comes. This natural cycle in crayfish farms is enhanced by controlling water levels.

An impounded swamp forest which is flooded in the winter and spring and drained in the summer is ideal for crayfish. Fish predators are controlled within the impoundments to improve the harvest.

In India also (Southern parts of West Bengal including Sunderbans) scientific aquaculture is being extensively practised.

VI. ***Enhancement of Wildlife:*** Wildlife enhancement is said to be the best management practices of ecosystem. The management recommendations given by Weller (1978) for Prairie pothole marsh site, is an excellent example of multipurpose wildlife enhancement. These management practices of Weller in sequence are as follows (Mitsch & Gosselink, 1986):

"1. When a pothole is in the open stage, with little emergent vegetation, the cycle is initiated with a spring drawdown. This stimulates the germination of seedlings on the exposed mud surfaces.

2. A slow increase in water level after the drawdown is best to maintain the growth of flood to learnt seedlings without shading them out in turbid water. Shallowly flooded areas attract dabbling ducks during the winter.

3. The drawdown cycle is repeated for a second year to establish a good stand of emergents.

4. Low water levels are maintained for several more seasons to encourage the growth of perennial emergents such as cattails.

5. Stable, moderate water depths for several years promote the growth of rooted submerged aquatic plants and associated benthic fauna, which make excellent food for waterfowl. During this period, the emergent vegetation gradually dies out and is replaced by shallow ponds. When this occurs the cycle can be re-initiated as in (1) above.

6. Different wetland areas maintained in staggered cycles provide all stages of the marsh cycle at once, maximizing habitat diversity".

It may be mentioned that in the coastal marshes, wildlife management uses the similar strategy.

▲ 7.3.4.1.3 National Wetland Conservation and Management Programme (NWCMP) by MoEF, GOI

Freshwater bodies perform many vital functions as listed below:

- Provide food, fodder, fuel and water for domestic, irrigation, and industrial purposes
- Support fisheries and a number of rare and endangered species of flora and fauna

- Maintain natural biodiversity
- Help in regulating hydrological regimes, flood control, and recharging of aquifers.

Recognizing the importance of protecting such water bodies, the Government of India operationalized a wetland conservation programme in 1985/86 in close collaboration with concerned State Governments. Several steps were taken to arrest further degradation and shrinkage of water bodies due to encroachment, siltation, weed infestation, catchment erosion, surface run-off carrying pesticides and fertilizers from agricultural fields, and discharge of domestic sewage and effluents, which resulted in deterioration of water quality, prolific weed growth, decline in biodiversity and other associated problems.

The wetlands encompass diverse and heterogeneous assemblage of habitats ranging from lakes, estuaries, river flood plains, mangroves, coral reef and other related ecosystems. Abundance of water at least for a part of the year is the single dominant factor.

Ramsar Definition: Ramsar is a city in Iran where the first *World Convention on Wetlands* was held on 2nd February 1971. The Ramsar Convention defines wetlands as given below:

> 'Wetlands are area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres.'

This definition talks about the maximum water depth in case of marine areas, for these to qualify as wetlands. However, it does not indicate the same for other aquatic bodies. Therefore, it becomes difficult to classify other aquatic bodies into wetland group.

In order to prepare a status of wetlands in USA, the 'US Department of Interior Fish and Wildlife Service Authority' adopted the following definition of Cowrdin in 1979:

> 'Wetlands are lands, transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by the shallow water.'

For the purpose of this classification, wetlands must have one or more of the following attributes.

- At least periodically the land supports predominantly hydrophytes.
- The substrate is predominantly undrained hydric soil.
- The substrate is non-soil and is saturated with water or covered by shallow water sometime during the growing season of each year.

Benefits of Wetlands: Wetlands offer several substantive benefits. Unfortunately, they are often not fully understood. Some of the most obvious advantages are listed below (MoEF, GOI, 2007):

- Life support systems.
- Winter resorts for a variety of birds for shelter and feeding.

- Suitable habitats for fish and other flora and fauna.
- Effective in flood control, waste water treatment, reducing sediment loads and recharging of aquifers.
- Valuable for their educational and scientific interest (especially their high diversity or species richness).
- Recreational benefits (swimming, diving, tourism).

Policy Support: National Environment Policy (NEP), 2006: The National Environment Policy (NEP), approved by the Cabinet on 19 May 2006, recognizes the numerous ecological services rendered by wetlands. The NEP states:

> 'Wetlands are under threat from drainage and conversion for agriculture and human settlements, besides pollution. This happens because public authorities or individuals having jurisdiction over wetlands derive little revenues from them, while the alternative use may result in windfall financial gains to them. However, in many cases, the economic values of wetlands' environmental services may significantly exceed the value from alternative use. On the other hand, the reduction in economic value of their environmental services due to pollution, as well as the health costs of the pollution itself, are not taken into account while using them as a waste dump. There also does not yet exist a formal system of wetland regulation outside the international commitments made in respect of Ramsar sites. A holistic view of wetlands is necessary, which looks at each identified wetland in terms of its causal linkages with other natural entities, human needs, and its own attributes.'

The Environmental Policy identifies the following six-fold Action Plan:

1. Set up a legally enforceable regulatory mechanism for identified valuable wetlands to prevent their degradation and enhance their conservation. Develop a national inventory of such wetlands.
2. Formulate conservation and prudent use strategies for each significant catalogued wetland, with participation of local communities, and other relevant stakeholders.
3. Formulate and implement eco-tourism strategies for identified wetlands -through multi-stakeholder partnerships involving public agencies, local communities and investors.
4. Take explicit amount of impacts on wetlands of significant development projects during the environmental appraisal of such projects; in particular, the reduction in economic value of wetland environmental services should be explicitly factored into cost-benefit analysis.
5. Consider particular unique wetlands as entities with 'Incomparable Values', in developing strategies to their protection.
6. Integrate wetland conservation, including conservation of village ponds and tanks, into sectoral development plans for poverty alleviation and livelihood improvement, and the link efforts for conservation and sustainable use of wetlands with the ongoing rural .infrastructure development and employment generation programmes. Promote traditional techniques and practices for conserving village ponds.

Formulation of Management Action Plans: The State Governments are encouraged to formulate long-

term comprehensive Management Action Plans (MAPs) for a period of 3-5 years, preferably 5 years, coinciding with the Plan period The State Governments are expected to define objectives taking into consideration factors responsible for degradation of the wetland. The Action Plan should also have short-term objectives to cater to immediate problems confronting wetlands and to go in for immediate rectification measures. The comprehensive MAP should be based on integrated and multi-disciplinary approach. The MAP should cover the following aspects:

- Location, area and altitude, latitude, longitude, depth, ecological features, inflow-outflow pattern, zonation, if any, geological and climatic features
- Baseline data, i.e. pre-project status in terms of various relevant parameters, particularly, soil texture, extent of silt, quantum of biomass, soil moisture content, quality of water, extent of obnoxious weeds, groundwater level and variety and range of biodiversity in terms of flora, fauna including birds and fish
- Land use pattern in the catchment including vegetation, human settlements, agriculture, and major and minor industries
- Sources of qualitative and quantitative inflow of effluents, sewage, pesticides, and other chemicals entering into wetlands
- Flora including distribution of macrophytes, plankton, and benthos
- Fauna including details of major animal groups like birds, fishes, reptiles, mammals. Details regarding invertebrate fauna should also be included
- Population/families directly dependent on wetland resources
- Socio-economic survey of wetlands through questionnaires
- Cultural and indigenous practices of wetland resource utilization
- Jurisdiction of various concerned departments dealing with wetland conservation
- Existing conservation measures taken
- Interface with researchers to incorporate relevant research findings in MAPs
- Involvement of people up to panchayat level in decision-making
- Wise-use practices of wetland research, if any in existence
- Monitoring mechanism at local and State levels

7.3.4.2 Urban Land

Urban area provides better amenities for an all-round growth of civil life and job opportunities but at the same time it contributes to the accumulation of wastes, pollutants, and slums etc. which adversely affect the environmental conditions. The measures suggested to combat common urban problems so as to

minimise the harmful effects on environment are as follows:

- Expansion of urban areas should not be encouraged at the cost of rich forest cover and fertile agricultural land.
- Excessive use of underground water (causing ground surface collapse) for meeting domestic as well as industrial uses must not be continued. Water from nearby canals, rivers or other water bodies with essential purification can be used for these purposes as an alternative.
- Urban garbage is the regular phenomena especially in India. The concerned municipalities must play their role properly; particularly take adequate steps to have the sincerity in removing the heaped garbage to a particular place so that these can not aggravate the pollution further.
- Emission of aerosols particularly from vehicles should be stopped in strict adherence to legislation, to be adopted if required. The concerned authorities must make provision for penalty if required in case of violation of the rule and must compel vehicle owners to use antismoke devices.
- In an urban area, further developmental activities must be regulated (i.e. the scale of development) so that it does not go beyond the carrying capacity of the area concerned. If permitted it may cause unhygienic conditions and even great disasters.
- Planners and decision makers must think over as to how to get rid of the problem of congestion (excessive pressure of population in urban area) especially in the developing countries which generally causes high degree of pollution.
- Afforestation should be launched on vigorously. Much more trees should be planted within the urban area to minimize the level of pollution (Singh, 1991; De and Jana, 1997).

■ 7.3.4.3 River Valley Planning

It is not a denying fact that most of the early civilizations were developed in the valleys e.g. Sind Valley civilization, Nile valley civilization etc. River, on one hand, provides many more resources and environment for multi-development and creates problems in terms of hazards on the other. In the present juncture of population explosion and economic setback, planned river valley development is considered to be an urgent need.

▲ 7.3.4.3.1 Objectives

The main objectives of river valley planning are as follows:

1. To save property, animal lives and civilians from the violent / disastrous effects of floods.
2. It provides extensive and better irrigation facilities to produce bumper crops as well as to reduce uncertainty and risk by agriculture due to the vagaries of monsoonal rainfall.
3. It brings more area under cropping practices/cultivation.

4. To generate hydroelectricity essential for industries and domestic use in urban and rural areas.
5. Integrated measures such as rehabilitation of the displaced villages due to flooding, modern methods of controlling floods, improved agriculture, establishment of dairy farming, demonstration farms, animal husbandry, development of agro-based and heavy industry, material measures etc. for the overall prosperity of a riverine region.
6. To open up new possibilities by reducing unemployment, bringing new employment opportunities and overall generation of wealth in the river basin.
7. It creates new investment opportunities which culminate in surplus income, savings, consumer demand and finally industrialization.

▲ 7.3.4.3.2 Damodar River Valley Planning: A Case Study

The river Damodar (formerly known as 'River of Sorrow') was planned for a unified multipurpose basin development. The main objectives of the planning were conceived of:

- Flood control.
- Control and promotion of navigation.
- Promotion and operation of drainage, water supply and different irrigation schemes.
- Generation, transmission and distribution of hydroelectric power.
- Control / checking of soil erosion.
- Promotion of different afforestation schemes.
- Undertaking of public health measure.
- Promotion of agricultural, industrial, trade and commerce in order to raise the living standard of the people in the area concerned.

The various schemes adopted in the planning project are as follows:

- In the Tilaiya, Konar, Maithan and Panchet hill four dams (mainly for flood control) with hydel power stations (except Konar) have been constructed aiming at a total capacity of 104 mw (in the 1st phase)
- Four dams at Bokaro, Balphari, Aiyar and Bermo along with hydroelectric stations have been developed (in the 2nd phase).
- At Durgapur, an irrigation barrage along with 2500 km long irrigation-cum-navigation channels to irrigate 4.17 hectares of land in Burdwan, Hooghly and Howrah Districts of West Bengal.
- Three thermal power stations at Bokaro, Durgapur, Chandrapura have been set up (total capacity is 957000 kw) to facilitate power supply in the Damodar Valley and adjoining regions of Bihar and West Bengal.
- A power grid (1280 km of transmission lines) with a number of substations and receiving stations has been made to meet the power requirements of the industrial belts of Bihar & West Bengal and Calcutta

Metropolitan Area.

- Soil conservation, afforestation measures, development of fisheries and control of malaria.
- Other benefits include building of erosion resisting structures in the catchment area i.e. check dams (Adivasi dam, Deochanda dam, Bachhi dam and Gauria Karma dam) to hold back rain water, prevent gully erosion and water supply for irrigation ; scientific maintenance of denuded forest by large scale plantation of timber and other fast growing species ; setting up of large farms at Panchet, Konar, Burlu, Urwan, Sewai, Deochanda and Panagarh for augmenting country's food production ; supply of power from D.V.C System to the coal mines of Jharia and Raniganj and Eastern Railway ; reclamation of marshy lands; supply of drinking water and recreational facilities for swimming and boating in the lakes (Khullar, 2000; De and Jana, 1997).

■ 7.3.4.4 Industrial Land

The modern economy is mainly based on industrial development but it contributes significantly to the environmental problems in terms of air, water and land pollution which needs pollution control measures for habitable environment. The air pollution needs the following measures:

- To create awareness among people and government bodies regarding the causes and effects of pollution, to monitor regularly the level of air pollution, to search alternative products (less harmful) e.g. solar-powered cars, to improve the existing devices of pollution control and to adopt new effective devices etc.
- A number of instrumental devices can be used to control pollutants e.g. (a) Bag Filter, a filtering device used to filter and separate particulate matters from the industrial fumes, (b) Wet Scrubbers, are used to clean the gases by wetting them with water, (c) Cyclone Separator, is used to filter and separate particulate matters of larger size (> 50 micrometer), (d) Electrostatic precipitators, High Energy Scrubbers and Fabric Filters devices used in case of particulate matters of smaller size (< 1 micrometer).
- By Flue Gas Desulphurization (FGD) methods, sulphurdioxide arising out of fossil fuel combustion can be removed from stock gases.
- Combustion Modification methods can be used to control and reduce the emission of nitrogen oxides : carbon monoxide.
- Activated carbon powder may be used which has the capacity of absorbing many pollutants.
- In the factories, height of the chimneys must be raised above to reduce ground concentration of toxic elements.
- It may be mentioned that the Government of India has already introduced 'Air Prevention Act and Control Bill, 1931 to control air pollution in the big cities. Under this Act some measures have already been taken but not to the desired level.

Water is getting polluted day by day by the large industrial complexes as they contribute enormous

volume of waste disposal to the nearby rivers, canals etc. which necessitates appropriate measures to improve the water quality. The owner of the industries as well as the concerned municipalities must be active and cautious to minimise the pollution loads to nearby water bodies. The Govt. of India has declared a number of water acts but who cares? The Central Water Control Acts are – (1) The Damodar Valley Corporation (Prevention of pollution of water) Regulation Act, 1948, (2) The River Boards Act, 1956, (3) The Merchant (Amendment) Shipping Act, 1970, (4) The Water (Prevention and control of pollution) Act 1974, (5) The Water (Prevention and control of pollution) Cess Act, 1977. In addition, the Govt. has taken special care for polluted Ganga River by constituting Central Ganga Authority (CGA). There are many kinds of solid waste pollutants viz. industrial wastes, mining wastes, municipal wastes, radioactive wastes, agricultural wastes, animal wastes, human wastes, packing wastes etc. Here the authors are concerned with the industrial wastes mainly. Industrial wastes include large amount of abandoned items heaped near the factories e.g. huge quantity of bagasse of sugar industry, dangerous waste substances of copper industry, ashes of thermal power stations etc. These heaped wastes are susceptible to land and water pollution. The waste disposal needs following measures:

- Heaps of solid wastes are to be cleared regularly by Municipality or concerned industries and carried by trucks or lorries to dump sites.
- Proper and scientific method of disposal of solid wastes involves (a) sorting of waste substances, (b) dumping of non combustible substances into suitable dump sites, such as landfills, depressed ground, open wasteland etc. (c) burning of combustible wastes by specially designed Multiple Hearth Furnaces (MHF) and Fluidized Bed Furnaces (FBF). It may be pointed out that the burning of solid wastes may solve the problem of their disposal and contribute energy for diverse uses.

Noise from the industries creates another environmental problem which must be controlled in time. Noise pollution can be checked in two ways i.e. (a) by reduction-enclosure of machinery with sound absorbing material may reduce the intensity of noise from the industries. A number of material such as cinder block (10 cm thick plastered on one or both sides), glass (5/8 cm thick) can have effective role in reducing the intensity of noise, and b) by noise control-silencers to the machines, proper greasing of vital parts of machines to reduce friction, control of transmission paths of sound waves, to make public conscious regarding the bad effects of noise pollution etc.

It may be mentioned that different international organizations have adopted different programmes with special reference to industries as given below:

1. International Biological Programme (IBF) by ICSU in 1964.
2. Special Committee for International Biological programme (SCIBP), an organization of ICSU.

3. Man and Biosphere Programme (MAB) by UNESCO in 1970.
4. International Hydrological Decade (IHD) 1965-1974.
5. International Hydrological Programme (IHP), a UNESCO sponsored project.
6. Integrated Project on Arid Lands (IPAL) launched by UNESCO in 1976.
7. Scientific Committee on Problems of Environment (SCOPE) by ICSU in 1959.
8. United Nations Environmental Programme {UNEP) by the UNO.
9. Scientific Committee on Oceanic Research (SCOR).
10. Scientific Committee on Water Research (COWAR).
11. International Centre for Integrated Mountain Development (ICIMOD) in 1981.
12. International Decade for Natural Disaster Reduction (IDNDR), 1991-2000 – a United Nations sponsored programme.

Under the Man and Biosphere (MAB) programme, 14 scientific projects (e.g. projects 1, 2, 3 ...14) have already been carried out in collaboration with different government and non government organizations. Each project emphasizes on different types of environmental impact. Projects 10, 11, 13, & 14 mainly concentrated on industrial impacts on environment are as follows:

Project 10: 'Effects of man and his Environment on Major Engineering works.'

Project 11: 'Ecological Aspects of Energy Utilization in Urban and Industrial Systems'

Project 13: 'Perception of Environmental Quality'.

Project 14: 'Research on Environmental Pollution and its Effects on the Biosphere.'

In India, Acts have already been passed (1974, 1981 and 1988) to control air and water pollutions. The Central Pollution Control Board have taken necessary steps for systematic monitoring of air and water quality, The Board made a sample study of 3000 water monitoring stations and 106 stations for air. More than 3,000 industries have been prosecuted. In addition, Motor Vehicles Act was amended in 1988 to control the pollution caused by vehicles (Singh, 1991; De and Jana, 1997).

Different pollution control Boards at State level are also taking drastic steps against the industries which are intentionally violating rules and regulations.

■ 7.3.4.5 Mining Land

Minerals give economic prosperity but mining of minerals leave behind a series of bad effects on environment which needs to be managed. The measures suggested are as follows (Babu and Namdeo, 1992; Melkania, 1992):

- Due to blasting in the mine, concentration of crusher plant, air is polluted and particulates of the atmosphere are increased. These phenomena can be overcome by wet blasting at the mines as well as by installation of electrostatic dust separating screen at the crusher plant, where fine particulates and dust is removed.
- Abandoned mines are subjected to collapsing of land surface. Defunct mines must be filled with sand stowing.
- One of the major problems in the mining areas is acid mine drainage. Back fill operations are necessary for reducing the quantity of acid mine drainage.
- Several methods for treating acid mine drainage water can be recommended which include demineralization methods (i.e. ion exchange, reverse osmosis, electro-dialysis, flash distillation), alkali neutralization methods (i.e. hydrated or calcined lime, limestone dolomite, alkaline potassium permanganate) etc.
- For preventing the leakage of acid mine drainage, construction of earth dam at a distance from and around the base of the dumped overburden to impound the runoff may be taken into account so that impounded runoff does not percolate down to the saturated zone and pollute the ground water.
- Reduction of waste volume can be done by the re-use of water. In such case, some preliminary treatment viz. settling in lagoons to remove suspended matter can be taken in hand.
- Generally in a mining area, the overburden is dumped as a result the soil and sub-soil lying beneath for a long time become inhospitable for plant growth. So, in the development plan of a mined area, reclamation aspect as an integral part should be incorporated.
- Concentration of dust (produced by blasting) on vegetation; discolour the foliage which reduces the chlorophyll content of plant as well as biological productivity which can be checked by wet blasting.
- People of mining areas fall easy prey to several diseases. They have to make aware regarding the health hazards through audiovisual aids such as seminars, firms, discussions, public meeting etc.
- Afforestation and reforestation in the abandoned/defunct mining areas should be encouraged.

▲ 7.3.4.5.1 Mineral Policy

Minerals once extracted are lost for ever. The guiding principle of mineral policy, therefore, is social economy and conservation. *The National Mineral Development Corporation Limited* was set up in November, 1958, for the exploitation of minerals other than coal, oil and natural gas. Till now, the mineral policy of the Government of India has been based on the following assumptions:

(i) the mineral wealth of the country is a natural resource, limited and non-renewable; (ii) it is required for developmental and strategic needs of the country; (iii) its exploitation should strike a balance between the immediate needs of the present generation and those of the future generations; (iv) it should meet the requirements of conservation and environment.

The Central and State Governments had framed rules and guidelines for the grant of mine leases and for the extraction and export of minerals. The Central Government had also reserved for itself, apart from coal and oil, the exclusively exploitation of 13 important minerals, viz. iron ore, manganese, chrome,

sulphur, gold, diamond, copper, lead, zinc, molybdenum, tungsten, nickel, and platinum. Finally, the Government always attempted to make the best use of the available mineral resources through scientific methods of mining.

New Mineral Policy, 1993: The major objectives and strategies to achieve the objectives and strategies of the new mineral policy are as follows:

- *To explore for identification of mineral wealth on land and off-shore:* Under the New Mineral Policy, the Government will continue exploration of the mineral wealth of the country and special attention will be given to the development of (i) strategic minerals, (ii) those minerals in which India has poor or just adequate resource base and (iii) those minerals which are required for electronomic and other high-tech industries.
- *To develop mineral resources taking into account the national and strategic considerations:* The strategy of development adopted by 1993 Mineral Policy would ensure (i) a regular supply of mineral raw materials for industrial production; (ii) exploration and supply should keep the present needs as well as future long-term needs of the country; (iii) adoption of efficient measures of processing of minerals and effective measures for conservation; and (iv) adoption of scientific methods of exploration.

  In this connection, the New Mineral Policy invites foreign equity and technology participation in exploration and mining of high value scarce minerals. Joint ventures with Indian and foreign equity participation would be encouraged. The Government would also grant mineral concessions for small deposits in scheduled areas to scheduled tribes.
- *To minimise adverse effects of mineral development in the forests, environment and ecology through appropriate protective measures:* Extraction and development of minerals are closely inter-linked with other natural resources like land, water, air and forests. The areas in which minerals occur are ecologically fragile and some are biologically rich. Hence, the New Mineral Policy takes a comprehensive review to facilitate the choice or order of land use keeping in view the needs of development as well as the needs of protecting the forests, environment and ecology.

  Under the New Policy, operations were ordinarily be taken up in identified ecologically and biologically rich areas. No mining lease granted to any party either private or public with a proper mining plan, including the environmental management plan approved and enforced by state authorities. The environmental management plan adequately provide for controlling the environmental damage, restoration of mined areas and for plantation of trees according to the prescribed norms. As possible, reclamation and afforestation should play concurrently with mineral extraction. Efforts were made to convert old disused mines into forest and other appropriate forms of land use.

- *To promote foreign trade in minerals:* Minerals have been important source of foreign exchange earnings. The policy of export of minerals will keep in view: (i) the mineral inventory position and (ii) long term needs of the country. As far as possible, effort will be made to export mineral in value added form.
- *To promote research and development of minerals:* The New Mineral Policy emphasises the promotion of research and development, technology upgradation, research in mining methods, development and introduction (Datt and Sundharam, 1998).

■ 7.3.5 CONCEPT OF WASTELAND AND ROLE OF NATIONAL WASTELANDS DEVELOPMENT BOARD

■ 7.3.5.1 Concept of Wasteland

The term 'Wasteland' in India has a history going back to the early British colonial period, at which time it simply referred to uncultivated land (including forests). Once the colonial authorities recognized that forests were being depleted and decided to protect them through the establishment of a Forest Department (mid-19th Century), the definition of 'Wasteland' was narrowed to uncultivated non-forested land. Once most of the fertile non-forested land came under cultivation by around the turn of the last century, the term increasingly was understood as applying to land that was biologically unproductive as a result either of natural factors (e.g. desert climate, mountainous topography) or of human impacts (e.g., soil erosion, overgrazing or salinization).

Now-a-days, the term wasteland is essentially understood to mean low-quality land from an agricultural point of view, often referred to as degraded land. The term 'degraded land' is frequently used to refer to dessert or high mountain areas, even in the absence of any evidence that these areas have been degraded from some previous better condition (Hoeschele, 2003).

In India, wastelands have been categorised variously by different agencies such as by the physical status of the land as observed with reference to different kinds of degradation, by landuse, by property right, by problem and their various combinations. A substantial difference is there between the various estimates made by different agencies at different times. These differences are largely not because of changes in the extent of wastelands at different times but often because of the way wastelands are defined by various agencies and the methodologies used for their estimation. Estimate of wastelands made by SPWD in 1984 combined the effect of three problem categories water, wind, and salinity/ alkalinity with seven landuse categories: (i) forests, (ii) barren and unculturable land, (iii) permanent pastures and other grazing lands, (iv) culturable wastes, (v) fallows other than current fallows, (vi) current fallows and (vii) net area sown. The earlier attempts in wastelands estimation did not relate land degradation to its causes appropriately,

especially its relation to both inappropriate water management as well as landuse in an areas.

NRSA's latest cycle of wastelands mapping gives an indication as to the stage of degradation at a national level. *National Remote Sensing Agency* (NRSA) has used satellite mapping for preparing a spatial database on wastelands for the entire country in two cycles completing in 2000 and 2005 respectively, on a 1:50,000 scale at the district level. The first cycle uses a 13-fold classification covering physical parameters and factors leading to degradation. According to this cycle, the total wastelands in the country have been estimated to be 63.8 mha out of which the cultivable wastelands comprise more than 70 percent (45 mha). In the second cycle, the severity of degradation has been further looked into. Like gullies have been further categorised as deep, medium and shallow. In case of land with/ without scrub, the process also has been built-in leading to 28 categories of wastelands, which require different reclamation technologies.

As per the *NRSA Wastelands Atlas 2005*, the estimate of degraded lands suggests that severe and extreme degraded lands (wastelands) cover 55.26 mha in the country. Moderate degraded lands (fallow lands) cover 13.76 mha whereas slight to moderate degraded lands which comprise of single cropped areas cover 67.49 mha taking the figure for total area under degraded lands to 136.51 mha. Attempts so far have not been able to capture the social and institutional factors leading to degradation.

Understanding the genesis of wastelands is the first key step to effectively prevent, arrest and reverse the land degradation process. Wastelands are integral to landform-land capability-land use, surface and groundwater regime and other climatic conditions. The extent and intensity of resource use are determined by the right of individual households, community or the state over the resource-use (whether land, water or forest), institutional factors like land tenure, fragmentation of landholdings or the nature of association among different agents for defining the manner of use of common or public resources and economic factors like subsistence needs or value of the produce. This extent and the intensity beyond a limit set by nature leads to land degradation.

Defining Wastelands: Wastelands are generally looked at from and production point of view whether it is grass, agriculture or forests. Deserts in Rajasthan are wastelands from agricultural point of view but the salt spots attract the tourists, which provide employment to the local people. There is a need for an alternate definition which includes employment, livelihood and income generation. Further, the history of wastelands mapping and estimation indicates that they have always been mapped as a landuse unit. The classification could be generic or adjectoral and the estimates have varied. The estimates have also been different. *National Bureau of Soil Survey and Land Use Planning* (NBSSLUP) harmonises its data sets like land degradation map and soil map to produce the problem land / wastelands map. A combined or

integral approach works better in terms of wastelands classification. NBSSLUP has divided the country into 20 zones and 60 sub-zones. Wastelands have been referred to as low productive lands. The average productivity in each zone and sub-zone has been worked out and with respect to that the productivity is defined as low or high and the deviation worked out. A relook at the definition should involve having a relook at the existing data in terms of productivity for marginalised population and would be like doing land suitability mapping for wastelands similar to the one done for crops. The indices would be different since the exercise is specifically looking at poor people and poor lands. Since erosion or deposition is part of the natural process, it is important to identify human induced degradation processes. Dr. D. C. Das, Vice President for India of *World Association of Soil and Water Conservation*, New Delhi presented some issues related to definition and categorisation. He was of the view that defining wastelands and categorising the same should be done after taking comprehensive stock of projected demands of phytomass and for lands to produce the same for the population expected in 2050. He mentioned that trend analysis of demands on land over the decades and future projection suggest that there are many stakeholders for land and that agriculture cannot have a captive claim on these lands. Due to the diversity of production and productivity figures and disproportionate deployment of country's land area, this data cannot help evolve an acceptable definition for different stakeholders. Similarly, degradation as evolved today includes the intrinsic risk for all types of land utilisation including farming, land administration and institution. Land degradation alone cannot help evolve a definition or categorisation. Because of intrinsic nature of degradation processes and dynamic nature of wastelands, a composite approach based on Land Quality (LQ) and a set of representative key LQ parameters can perhaps help develop a definition that would be acceptable to most of the stakeholders. Categorisation could be logically done by using the Pressure-State-Fallout-Response (PSFR) analysis. There is a need to locate technologies and test their cost effectiveness (Singh and Bhaduri, 2006).

Redefine and Refine Wastelands: *Society for Promotion of Wastelands Development* (SPWD), during the past 23 years of its operation, has been developing the wastelands in the Watershed Management and Joint Forest Management programmes in collaboration with a number of non government and voluntary organisations. In its projects, it has not only focused on the biophysical aspects but also on social aspects of self-help groups, gender issues, poverty reduction, social upliftment and livelihood aspects. In its work, the organisation has collected a large volume of biophysical and socio-economic data, more specifically in Rajasthan (70,000 ha) and Jharkhand States. Based on this experience, it has felt the need to redefine the wastelands combining biophysical and socio-economic aspects.

Keeping this in view, SPWD organised a one day consultation meeting on 18th February 2006 with the

objective for "Estimation of Extent of Wastelands and their Potential for Enhancing Livelihoods of Marginalised Rural Population". A number of resource persons from NGOs, survey organisations of the Government of India, freelancers and SPWD specialists and programme staffs were present in the meeting. After extensive interaction between and among the participants and stakeholders, it was concluded that even though the first estimate made by SPWD in 1984, and subsequently by the Department of Space, Ministry of Agriculture, Ministry of Forests, etc. differ among themselves in parameters and numbers, they should serve the purpose of SPWD for its activities. SPWD is interested in gross estimates as a user of information and it can not involve itself in the "estimation of wastelands" which is the function of various organisations mentioned above.

However keeping in view SPWD's mission for enhancing livelihood of marginal rural poor people, it was agreed that all the stakeholders who are interested in the survey will co-operate in integrating the additional biophysical and socio-economic information SPWD wishes to have to refine and redefine the wastelands. Incidentally, it appears that the Department of Space, Govt. of India has prepared an Atlas of Wastelands upto 1: 50,000 scale and it is integrating it with cadastral maps (Tejwani, 2006).

Basically, it was the dream of Mr. Rajiv Gandhi (late Prime Minister of India) to develop the wastelands and accordingly in 1985, with his pioneering efforts and concern, the 'National Wastelands Development Board' was formed. The UPA (United Progressive Alliance) Government has included his dream of wastelands development in its common minimum programme (CMP) and is working towards it. Emphasis has been placed upon the role of *Panchayati Raj* institutions to take on this responsibility. *Panchayats* can offer options and implement programmes with the support of NGOs and local bodies.

There are also programmes of The World Bank, Integrated Development Programme, Watershed Development Programme, etc. and the government is planning to spend Rs. 12,000 crore in the next five years towards wastelands development. It is now a big challenge to develop and regenerate wastelands for agriculture purpose (Ramesh, 2005).

■ 7.3.5.2 Role of National Wastelands Development Board

National Wastelands Development Board (NWDB) was established in 1985, under the Ministry of Environment and Forests, mainly to tackle the problem of land degradation, restoration of ecology and to meet the growing demand of fuel-wood and fodder at the national level. During 7th Five Year Plan, the strategy adopted by the National Wastelands Development Board was more on tree planting activities. In the year 1992, the Department of Wastelands Development under the Ministry of Rural Development (now Ministry of Rural Areas and Employment) was created and National Wastelands Development

Board was placed under the Department. The Board was reconstituted in August 1992 and was made responsible for development of wastelands in non-forest areas, checking land degradation, putting such wastelands in the country into sustainable use and increasing bio-mass availability especially fuel-wood and fodder. After the composition of the 12th Lok Sabha, the National Wastelands Development Board has been reconstituted. It aims at creating a scenario where the Government acts as a facilitator and the people at the grass root level become the real executioner of the programme. Major programme implemented for improving the productivity of waste and degraded lands keeping in view with the poverty, backwardness, gender and equity is Integrated Wasteland Development Programme.

Integrated Wasteland Development Programme: It is one programme which is making sincere efforts towards the empowerment of the people so that a sense of collective responsibility can be evolved among them. The new guidelines for watershed development provide a paradigm shift in the traditional approach where the role of the Government is changed from that of governance to facilitation. The institutional arrangements envisaged in the guidelines can be seen as true reflections of the Agenda 21 where the sustainability comes through the involvement of people and the local bodies. The approach of watershed development in a holistic manner automatically strikes a prudent balance between environmental concerns and developmental aspirations. The efforts being made under the guidelines can be termed as sincere and honest as here the survival of life itself is at stake with the watershed development rather than the quality of life itself as compared to similar situations in the developed countries. In fact, the effective community control has been an integral part of the Indian social fabric which was fragmented by the colonial rule. This programme is an effort towards its restoration and a small step in the achievement of this goal which might turn into a big leap with the support from the people.

Integrated Wastelands Development Project (IWDP) Scheme: This scheme is under implementation since 1989-90, and has come to the Department of Land Resources along with the National Wastelands Development Board. The development of non-forest wastelands is taken up under this scheme. The scheme provides for the development of an entire micro-watershed in a holistic manner rather than piecemeal treatment in sporadic patches. The thrust of the scheme continues to be on development of wastelands.

The basic objective of this scheme is an integrated wastelands development based on village/micro watershed plans. These plans are prepared after taking into consideration the land capability, site condition and local needs of the people. The scheme also aims at rural employment besides enhancing the contents of people's participation in the wastelands development programmes at all stages, which is

ensured by providing modalities for equitable and sustainable sharing of benefits and usufructs arising from such projects. The major activities taken up under the scheme are (Ministry of Rural Development, GOI):

- In situ soil and moisture conservation measures like terracing, bunding, trenching, vegetative barriers and drainage line treatment.
- Planting and sowing of multi-purpose trees, shrubs, grasses, legumes and pasture land development.
- Encouraging natural regeneration.
- Promotion of agro-forestry & horticulture.
- Wood substitution and fuel wood conservation measures.
- Awareness raising, training & extension.
- Encouraging people's participation through community organization and capacity building.
- Drainage Line treatment by vegetative and engineering structures
- Development of small water Harvesting Structures.
- Afforestation of degraded forest and non forest wasteland.
- Development and conservation of common Property Resources.

7.3.6 LET US SUM UP

In this Unit the nature of ownership, occupancy and government control on land use in different countries has been dealt with in detail. Besides, policy measures in the conservation and management of wetland, urban land, mining and industrial areas as well as in the planning of river valley have been elaborately discussed with special reference to India. In addition, the purposive and significant role of National Wastelands Development Board in the development of wastelands has also been described in the present juncture of acute shortage and encroachment of productive lands.

7.3.8 SELF ASSESSMENT QUESTIONS

1. What is the main point to be noted in terms of government control on land use in developed and developing and or underdeveloped countries?

   Your answer should include the following point:
   - Controls are stricter in densely populated countries than in those with more favourable man-land ratios.

2. What are the main objectives of wetland management?
   Your answer should include the following points:
   - maintenance of water quality,
   - protection from floods,
   - to reduce erosion,
   - to provide a natural system for the processing of airborne pollutants,
   - creation of wildlife,
   - production of food, fodder and fibre,
   - to provide habitats for fish spawning and other organisms,
   - to provide aesthetic and psychological support for human beings.

3. Which vital functions the freshwater bodies perform?
   Your answer should include the following points:
   - Provide food, fodder, fuel and water for domestic, irrigation, and industrial purposes.
   - Support fisheries and a number of rare and endangered species of flora and fauna.
   - Maintain natural biodiversity.
   - Help in regulating hydrological regimes, flood control, and recharging of aquifers.

4. In the classification of wetland, which attributes should be taken into account?
   Your answer should include the following points:
   - At least periodically the land supports predominantly hydrophytes.
   - The substrate is predominantly undrained hydric soil.
   - The substrate is non-soil and is saturated with water or covered by shallow water sometime during the growing season of each year.

5. What are the measures needed for the treatment of solid wastes?
   Your answer should include the following points:
   - sorting of waste substances;
   - dumping of non combustible substances into suitable dump sites, such as landfills, depressed ground, open wasteland etc.;
   - burning of combustible wastes by specially designed Multiple Hearth Furnaces (MHF) and Fluidized Bed Furnaces (FBF).

6. Mention the name of organisations in India involved in wasteland management.
   Your answer should include the following points:
   - National Wastelands Development Board
   - Society for Promotion of Wastelands Development
   - National Remote Sensing Agency

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M.A. / M. Sc. in Geography
PART – I
Paper - IV :: Module – VII
Unit – 04

Module Structure

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■ 7.4.0 INTRODUCTION

In geographical studies the analysis of landuse is a very important aspect. Land use map provides guidelines for planning and development in future. In a land use survey, areas are grouped on the basis of land use criterion (i.e. the proportion of different land use classes to geographical area). It is laborious, expensive and time-taking, In preparing a land use map, the needs of different specialists as well as land users should be kept in mind. The first land use survey of Great Britain during 1930's may be cited as an example because it played a vital role in the planning of wartime agricultural development as well as post-war reconstruction of national economy.

Land use map shows the distributional aspect of land use patterns and spatial interrelationship. Further a correlation can be drawn between the pattern of land use and types and capabilities of :,oil, the surface configuration and situation of ground water. The land use maps have multifarious uses such as: (i) it can be used as tools of decision makers in exploring possibilities for regional development, (ii) to adjust land use types to land capability, (iv) to extend land utilisation into new potential areas, (v) to check misuse of land and (vi) to formulate planning policies.

Land use planning is essential to carry the burden of ever increasing population especially in the developing countries as well as to fulfill the desires and aspirations of the developed world.

■ 7.4.1 OBJECTIVES

After studying this Unit, you should be able to :

- Understand the objectives and principles of land use survey;
- Understand the different methods and techniques of land use survey;
- Explain the different methods and techniques adopted for rural and urban land use planning in both the developed and developing countries.

■ 7.4.2 KEY WORDS

Land! Use : It means the use of the land. The term may be defined as the putting up of a parcel of land for any purpose

Land Use Survey : This refers to the identification of existing land use and recording its various aspects.

Land Capability : It means productive potentiality and ability of a specific unit of land.

Land Use Planning : It refers to the placing of appropriate actions on a given land unit so that every bit of land can be utilised in its optimum.

■ 7.4.3 OBJECTIVES, PRINCIPLES, METHODS AND TECHNIQUES OF LAND USE SURVEY

▲ 7.4.3.1 Objectives of Land Use Survey

The main objective of land use survey is to identify the different uses of land. It is one of the essential attributes of land evaluation. The importance of land use survey can be assessed from the following points (De and Jana, 1947):

- **Limited Land Area for Human Habitation :** The total area of the earth's surface is 492,375,000 sq. km. of which land shares 143,775,000 sq. km. The entire land surface (one third of the earth's surface) is not conducive for human habitation because of some physical hindrances i.e. areas covered by permanent ice and snow, dense forests; rugged terrains, deserts and regions of exclusive rainfall. Out of that, the land which is habitable for human being and favourable for crop production comprises only two fifths of the earth's land area.

- **To Support Increasing Population :** As the land area suitable for human habitation is limited, land use survey is essential for the appropriate uses of land to support the increasing population. Land is understood differently from diverse angles e.g. to the cultivators it is the source of agriculture, to the urban people it is the site for setting up of industries, for the construction of buildings and so on. So the prime objective of land use survey should be the rational use of land for the cause of human welfare.

- **To Prevent the Mis-use/Over-use/Under-use of Land :** The five basic needs of mankind are food, cloth, shelter, communication and work. People try to fulfill these needs by the uses of land. Misunderstanding leads to improper use of land. For example, if an industry is set up or roadways are constructed at the cost of fertile agricultural tract, then it is misuse. Further if a tract of land is used beyond its carrying capacity, the quality of land deteriorates. Moreover, if a land surface is lying vacant without any practice, it is subjected to natural degradation. So, the survey of land use is necessary to enlighten the perception of the people about its practical utility as well as to prevent the misuse, over use and under use of land.

- Optimum Utilisation of Land: Because of the advancement of science and technology land is over-exploited in industrially developed countries, whereas in developing countries land is not utilised in its proper perspective due to financial constraints and low level technology in India, for example, under use/misuse of land is one of the burning problems. India is primarily an agricultural country where pressure on land is increasing tremendously. The acquired per capita land in India is slightly more

than one acre of which per capita cultivated land is below one acre. Keeping in viev, with such acute situation, micro level land use survey is an urgent need not only in India but also in other developing countries to meet the increasing population as well as for sustainable economic development.

▲ 7.4.3.2 Principles of Land Use Survey

Land use surveys are the "surveys of present land use" i.e. the recording of various aspects of existing land use. The survey of land use depends on the trio of factors - the purpose, scale of map and nature of the area concerned. It may be mentioned that most of the land use surveys primarily register the existing crops in their more or less regular geographical distribution. A typical example of a general land use survey is the 'World Land Use Survey' initiated by L. D. Stamp under the auspices of the International Geographical Union. In different countries different land use especially crop surveys have been carried our which reflect the ecological conditions for the growing of crops to some extent A special kind of survey is the "crop disease survey" where the nature and distribution of disease and degree of crop damages are investigated Again "crop survey" is done to obtain an inventory for the present and future production of crops under the existing management practices.

In case of "economic survey" more emphasis is laid on the farming system and the nature of farm buildings rather than the geographic distribution of individual crops. Further, "land allotment surveys" as well as "field pattern surveys" are concerned with different aspects of land use (i.e. especially the shape and size of the fields on which crops are raised). It may be pointed out that both these surveys register only the present use of land and not concerned with the potential land use. "Cadastral surveys"_ however, register the ownership aspects and provide data on the institutional aspects of land use.

Land use surveys play a vital role in land development planning because future plans can be chalked out depending on the present situation of all land aspects. Decisions in regard to the changes in land us? Pattern can be taken only after detailed investigation of present land use from the ecological socio-economic and cultural viewpoints. In industrially developed countries, ecological significance of existing land use draws special attention. Therefore it is difficult to derive. Sufficiently accurate conclusions on the ecology of a region from the existing land use maps.

Thus, land use survey is not like any other survey, it is something more than that which is enriched today by modern survey methods. The use of aerial photography and remote sensing techniques are of immense help in modern land use planning (De and Jana, 1997).

▲ 7.4.3.3 Methods of Land Use Survey

The methods of land use survey can be classified as reconnaissance, semi-detailed and detailed depending on the purpose and scale of observations. These are as follows (De and Jana, 1997).

● 7.4.3.3.1 Reconnaissance Land Use Survey

Basically reconnaissance land use survey is a preliminary survey to the detailed land use survey. This type of survey is carried out just to obtain a broad idea about the major land uses. The reconnaissance survey is often intended to identify the areas of potential importance for intensive land use practices Observations in the field are made at greater intervals. Reconnaissance land use map generally shows different types of land uses as well as miscellaneous land types. The scale of mapping is approximately 1 : 200,000 to 1 : 500,000 depending on the purpose and availability of base map (topographical sheets, aerial photographs etc.). Reconnaissance land use survey provides guideline for detailed land use survey.

■ 7.4.3.3.2 Semi-Detailed Land Use Survey

Semi-detailed land use survey is a middle range between reconnaissance and detailed land use surveys The main objectives of this land use survey are to locate and determine the types of land use in a region. In addition, this type of survey is carried out for basic investigations on lands in some specific areas, collecting basic information of land use for land use classification as well as planning and development. The mapping scale varies from 1 : 40,000 to 1 : 50,000 and occasionally 1 : 100,000. But 1 : 50,000 scale is commonly used for land use mapping.

■ 7.4.3.3.3 Detailed Land Use Survey

Detailed land use survey is carried out in order to show the location, types and patterns of land uses as well as degree of land use practices. Besides it gives sufficient information for the detailed prediction of potential land use and suitability for a particular land use. This type of survey is carried out in relatively small areas and at close intervals which is significant for the proper assessment of land use. The land uses are generally examined at intervals of 1/2 to 1/4 km. or even closer depending on the differences in land use and intensity of practices, In detailed land use survey, the scale of mapping is normally 1 : 25,000 or larger (1 : 20,000 to 1 : 15,000, 1 : 10,000 or even cadastral map of 1 : 4,000). The survey is laborious, expensive and time consuming. Thus the result of detailed investigations serves the land improvement and planning of land use.

▲ 7.4.3.4 Techniques of Land Use Survey

The techniques adopted in land use survey vary from simple field survey to the complicated remotely sensed observations. Based on the accuracy, instrument employed and area coverage, the techniques of: land use survey may be divided into (1) proximate sensing technique, (2) remote sensing technique (3) integrated survey techniques and (4) three-tier technique. It may be pointed out that each of the techniques has limitations but these techniques in combination must contribute a comprehensive land use map with up-to-date information.

● 7.4.3.4.1 Proximate Sensing Technique

Proximate sensing technique in land use survey is generally divided into (i) topographical survey and (hi) specific

form of land use survey as follows :

(i) Topographical Survey : It is the simplest form which can mark the location of different features accurately. Generally the land use classification of topographic maps is made by topo-survey techniques. It is not definite complete and detailed enough for a fruitful planning. These maps reflect the genera; use of a geographical area but can not provide sufficient information regarding specific land use practices.

(ii) Special Land Use Survey : It is an improved form of topographic survey_ This sort of survey has been developed to augment the utility of a map as an inventory of land use. In this land use survey, the surveyors generally traverse the ground, observe and classify the patterns of land use and finally plot them on a map. As a result, surveyors can appreciate the true nature of the ground and can suggest it for particular purposes. In addition to that, changes and variations in land use and their responsive factors are recorded. Special land use survey requires sufficiently trained manpower, huge financial investment and it does not cover the inaccessible areas which result in incomplete coverage. Thus it provides relatively intensive land use maps and detailed information.

■ 7.4.3.4.2 Remote Sensing Technique

(i) Aerial Photo Interpretation : In this survey photographs are taken through different cameras fitted in the aeroplane. These photographs are then analysed by the modern photo interpretation techniques. Photo interpretation techniques required special kind of instruments and knowledge. It may be pointed out that systematic ground checking is also essential in this type of survey. This technique may be used to study and compare past and present land use patterns which form a basis for the future use of land. Thus aerial photo interpretation technique covers large areas, speeds up survey, brings accuracy and avoids unnecessary field works.

(ii) Satellite Imagery Interpretation : This technique is much more sophisticated which can cover large areas Here the images are regularly transmitted from the earth satellites over periods. Satellite photography provides information regarding land use development especially the predictions of harvested crop acreages in different parts of the world with the change in season.

Modern satellite with sophisticated remote sensing appliances such as electro-optical and non photographic sensors has introduced a new dimension into the techniques of land use survey. For land use mapping, satellites were launched during seventies which are commonly known as 'Landsat'. These landsats take images of the land surfaces. Images later on are converted into codes and then literatures. This sophisticated technique helps researchers and planners to prepare inventory of land resources as well as to classify land use data and more accurately and rapidly. The landsat covers several hundred fields for preparing detailed ground surveys in order to obtain data on area, types and patterns of crops, nature of yield, livestock number as well as other socio-economic factors / attributes. The application of this technique in the developing countries is essential where land resources are not being properly utilized and where enormous population is to be fed.

■ 7.4.3.4.3 Integrated Survey Technique

The improvement in the use of land is essential to any significant increase in food supply. To attempt to develop land without first assessing resource potentialities and planning their development is to invite economic failure and permanent impoverishment of natural resources. Before development begins, therefore, the nature of resource potentialities should be carefully studied and an assessment be made of the suitability of the land for various kinds of use. Finally when economic and social factors are considered, detailed plans can be made for the most advantageous use of available resources. Many scientific surveys are made by geologists, pedologists, geographers and others as unrelated enterprises for special purposes. Such surveys do not promote well balanced consideration of development possibilities. Thus, crores of rupees are spent at random for research investigation on land for future planning The research workers being specialized in their own field furnish reports to the government concerned in an isolated manner without having recourse to the related phenomena or interactions between different attributes. As a result, the planners face difficulty in find' out correlation between these results and ultimately the entire endeavour is lost. If this is continued instead of finding out any solution, the problem will further be aggravated.

To overcome these shortcomings the integrated survey technique has been developed, in a systematic study if integrated approach is made, the problem as cited above may be solved. In the integrated survey technique the results obtained from one individual study can be correlated with other type of studies to be followed. Thus in an integrated survey, scientists of the relevant disciplines collaborate with the object of recording knowledge about resources which will lead to the classification of territory in terms of potential land use Their efforts are channeled towards a practical end and are made more effective by mutual help.

It is nothing but survey of a comprehensive character conducted by the scientists of several disciplines which are interrelated either on a scientific basis or on an operational basis. In this survey, each of the different disciplines forming a larger scientific unit accepts sub-ordinate position within the larger unit (coherent whole), without losing its individuality. The integrated survey is, thus, the latest and the most scientific one which supercedes all the existing techniques (proximate sensing techniques, remote sensing techniques etc.) of land use survey.

● 7.4.3.4.4 Three-Tier (Combined) Technique

The application of each and every technique in conducting a land use survey has some shortcomings whereas field observations on the grounds - aerial photo and landsat imagery interpretation in combined form when integrated meaningfully - provide accurate and more elaborate information about land use and land resources. This is characterised as the multilevel concept. Further, these help to correlate and verify the rest its of air photo and imagery interpretation.

Initially thorough field observations (proximate sensing) are to be followed for the identification of land uses, for detection of problems and finally assessment of potentiality. Generally the stratified-random sampling technique is used in ground level observation.

In the next phase, aerial photographs link the isolated stratified samples of the survey results and provide a base for field surveys. Aerial photo interpretation is the identification-keys to the land use and is, however, the best means for obtaining a multilevel land classification in contrast to the field based identification and classification of land use. It may be mentioned that in the light of multi-level land use classification, main groups of land use are identified first in a most generalised form and then these are further sub-classified on the basis of their specific use. Further, it may be pointed out that both air photo interpretation and multilevel concept greatly help the standardized classification of land use which help to inform people regarding resource potentiality and required management measures and act as a tool for interpretation to the researchers as well as assist and provide guidelines to the planners in their decision making processes.

In the last phase of land use mapping, imageries provide detail information about the development of land use in different time and space. It is very cheap as compared to ground survey. One of the major characteristics of the satellite imagery is the repetition of images at regular intervals. As a result this repetitive coverage records day to day, permanent and semi permanent changes in land use and seasonal variations in the types and patterns of land use. In addition, these help in the multidisciplinary analysis of natural resource potentials as well as socio-economic attributes which ultimately help long term regional planning. It may be pointed out that the repetitive ground coverages of satellite imageries are used in the reconnaissance field study. Lastly, it is to be noted that the technique whether aerial photo and or satellite imagery interpretation requires field verification otherwise the land use map may provide inaccurate information (De and Jana, 1997).

■ 7.4.4 LAND USE PLANNING METHODS AND TECHNIQUES: RURAL AND URBAN

Land use planning is essential to carry the burden of ever increasing population especially in the developing countries. However, the land-use planning methodologies adopted for rural and urban in both the developed and developing countries are diverse because of their circumstantial difference/s in physical outlook and need of the society. It should be mentioned in this context that land use planning is related to land capability assessment. Planning of land use can be done only after proper assessment of land capability.

Land reflects variable physical attributes and the planning process will be made easier if the land is classified into a manageable number of categories (Mather, 1986).

▲ 7.4.4.1 Rural

Land use planning and rural development is so intimately related that without former the later is meaningless, rather impossible. Rural development is essentially based on the effective planning of rural land use. Accordingly, it is a very difficult task to differentiate one from the other. The planning of rural land use is the process and rural development, on the other hand, is the result. In land use planning, not only more emphasis is given on the optimum use of land for sound economy, but also emphasis is equally placed on the rural problems which need to be managed for sustainable development.

In the planning process of rural land use the first and foremost duty is to identify general land use viz. crop land, vegetable garden, forest land, grazing land, water bodies, wasteland, homestead land etc.

Agricultural Land Use : As agriculture is the main component of rural economy, obviously emphasis is given on its successful development. For effective utilisation of agricultural land the following steps are involved as follows:

(1) The study of relief and drainage is to be made. In this direction it is essential to have contouring of entire village with the help of Dumpy Level so that terrain characteristics can be easily understood.

(2) Climate plays a dominant role in agricultural practices. The nature of temperature and rainfall behaviour throughout the year is very important for crop cultivation. It is the climate which indicates whether provision for irrigation is essential for crop production or not. Besides it is necessary to study the climatic disturbance (e.g. tropical disturbances and other associated features) for avoiding crop damage.

(3) Analysis of soil samples to assess the physical (texture, structure, moisture etc.) and chemical (pH, N. P. K., and organic matter) properties.

(4) Land capability classification is to be made on the basis of soil potentiality and related terrain conditions for optimum land utilisation.

(5) The farmers generally produce food grains, vegetables, fruits, varieties of pulses, oil seeds etc. depending on the fertility and favourable terrain conditions. A correlation can be drawn between soil types and intensity of cropping practices. It may be pointed out that cropping pattern (multiple, double, and mono) can be recommended only after land capability assessment.

The following facilities need to be provided for effective utilisation of agricultural land: • Soil testing facilities at the Panchayat level.

- H.Y.V. seeds of paddy, other cereals and commercial crops should be supplied to the farmers.
- Supply of chemical fertilisers and pesticides in reasonable price.
- Extension of irrigation facilities whether river-lift, canal, deep on shallow tube-well.
- Agriculture should largely be mechanised in order to augment production by using tractors, power-tillers etc.
- Extension of rural electrification.
- Loans and subsidies (especially from regional rural banks and co-operative banks) from government are to be provided to the farmers in larger scale.
- Establishment of vocational school for the training of farmers about various aspect of modern agricultural

system.

- Establishment of zonal seed bank by the Agricultural Ministry for proper maintenance of seeds.
- More agricultural markets should be developed.
- Each and every village should be connected to the nearby town at least by unmetalled road.
- Agro-based industries are to be encouraged which may also provide Jobs to the farmers during lean season.

Vegetable Garden : Open vacant space in a village court-yard can be used for vegetable production. Some parts of cultivated land (besides the paddy growing season) should be allocated for the production of green vegetables, pulses, oilseeds etc.

Grazing Land : A portion of land should be left for grazing purposes. It would not be appropriate to convert this for other profitable purposes.

Water Bodies : Indian Village are generally characterised by large number of ponds, but most of them are not economically utilized. Scientific pisciculture should be encouraged with suitable management practices.

Homestead Land : Comparatively secured highland as well as unsuitable agricultural land should be allocated for the development of settlement area, as it is observed, should be surrounded by agricultural land use.

Waste Land : Presence of waste land % fallow land is the common feature of Indian village. Waste land is to be utilized for social forestry / fruit culture and this can be done only after capability assessment.

It should be kept in mind that land use planning, in crude sense, relates to the scale of understanding the land capability assessment, A few of the methods which have been adopted both in the developed and developing countries are mentioned below :

● 7.4.4.1.1 The American Method

The Soil Conservation Service of U.S. Department of Agriculture introduced a well efficient technique of land classification (grading of land) for the purposes of soil conservation. The main objective was to assess the degree of limitation to land use (i.e. primarily in the planning of soil conservation work on farms and ranches). The classification or grading of land was done on the basis of the degree of limitation to offer a label whether the land is 'safe' or not for the cultivation (Hockensmith and Steele, 1949). The detailed method was described by Klingebiel and Montgomery (1961). Thus U.S.D.A. method provides three levels in its classification structure as follows (Davidson, 1980) :

1. *Capability Class :* It includes 8 classes which reflect various types of land (Fig.).
2. *Capability Sub-Class :* It indicates the type of limitations encountered within a class (limitations in

terms of different environmental problems such as climate, wetness, stoniness in the soil, soil erosion etc.).

3. *Capability Unit :* This is a sub-division of sub-class. Land in one capability unit includes many different soils where little variation is found in regard to degree and type of limitations to land use (see detailed land classification by U. S. Soil Conservation Service, Unit-V).

It may, however, be pointed out that this method can better be described as a framework for land capability assessment because it can be adopted to a wide variety of environmental conditions.

Planning measures / strategies are adopted separately for the eight categories of land use which varies from one to another depending on their nature of limitations. The limitations may be permanent or temporal. It is very difficult to remove the permanent limitations e.g. soil texture or stoniness whereas temporal limitations can easily be overcome (e.g. wetness by field drainage scheme or acidity in soil by lime/fertilisers).

This method is widely employed in USA, mainly in all local soil survey works and in identifying prime agricultural land for policy implementation and preservation. It has also been employed in many countries outside the United States (mainly in Australia, India and Venezuela) with some modifications as required (Mather, 1986)

■ 7.4.4.1.2 The Canadian Method

Land capability assessment in Canada was initiated by the Canada Land Inventory (1963) as a result of the Agricultural Rehabilitation and Development Act (ARDA, 1961). The Inventory presents a comprehensive survey of land capability and the prime task of it is to provide a basis for resource and land use planning (Canada Land Inventory, 1970, Report No. 1). It is generalized in nature and can not provide sufficient information at local level.

In general, the Canadian Land Capability Scheme has been modelled on the line of U.S.D.A. method although some important differences are found (Davidson, 1980). In this method, five land capability assessment schemes have been made separately for agriculture, forestry, recreation, wildlife-ungulates and water fowl (McCormack, 1971). The capability schemes in Canada have employed seven classes in contrast to eight of the U.S.D.A. method. It may be pointed out that in the classification schemes of agriculture, forestry and wildlife the limitations resemble to those of the U.S.D.A. system but they differ in regard to number and detailing. In the scheme of recreation capability classification, much greater modification was needed (Mather, 1986). In the present context, capability classification for agriculture and recreation are being cited as follows (table 1):

Table 1 : Soil Capability Classification fir Agriculture in Canada

Soil Classes	*Soil classes on the basis of limitations*	*Degree or severity of limitations/Characteristic features*
Class 1	Soils in this class have no significant limitations in use for crops.	Soils are deep, well to imperfectly drained, well moisture-holding capacity and well supplied with nutrients. No difficulty to manage and cultivate and reflect moderately high to high productive status for a wide range of field crops under good management measures.
Class 2	Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices.	Soils are deep and have well moisture holding capacity; little difficulty for cropping and management. Moderately high to high in I productivity for a fairly wide range of crops under good management practices.
Class 3	Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices.	Comparatively more severe limitations than class 2 which affect one or more of the practices (i.e. timing and ease of tillage, planting and harvesting, choice of crops, and conservation methods). Reflect fair to moderately high productivity for a fair range of crops under good management practices.
Class 4	Soils in this class have severe limitations that restrict the range of crops or require special conservation practices, or both.	Limitations affect one or more of the practices such as timing and easy tillage, choice of crops, planting and harvesting and conservation methods. Low to fair in productivity for a fair range of crops but may have high productivity for specially adopted crop.
Class 5	Soils in this class have very severe limitations that restrict their capability to produce perennial forage crops, and improvement practices are feasible.	Soils are not capable of use for sustained production of annual field crops due to much severity in limitation. Capable of producing native or tame species of perennial forage plants, and may be improved by farm machinery. Improvement measures needed such as clearing

Soil Classes	*Soil classes on the basis of limitations*	*Degree or severity of limitations/Characteristic features*
		of bush; cultivation, seeding, fertilizing or water control.
Class 6	Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible.	Provide some sustained grazing for farm animals. Limitations are so severe that improvement by use of farm machinery is impractical. Terrain may be unsuitable for use of farm machinery, or soils may not respond to improvement, or the grazing season may be very short.
Class 7	Soils in this class have no capability for arable culture or permanent pasture	This class includes rockland, other non-soil areas and bodies of water too small to show on maps.
Class 'O'	Organic soils (not placed in capability classes), a	

Source : Canada Land Inventory, 1970.

The Canada Land Inventory published maps (at a scale of 1: 250,000) showing land classification according to different schemes. Attempt has been made to synthesize information into one (overall assessment) and the objective of such attempt is to prepare an integrated map which can propose the best land use on the basis of capability. The methodology used for the analysis of land capability has been taken from the supporting description of the map although the detailed methodology for analysis varies from area to area. Thus, it may be pointed out that an overall analysis in combination with the land capability maps plays a vital role regional land use planning and development in Canada (Davidson 1980).

● 7.4.4.1.3 The British Method

In Britain, the Soil Survey Department developed a method of Land Use Capability classification on the line of U.S.D.A. scheme (Bibby and Mackney, 1969). The basic aim was to present the results of soil surveys in such a form which may be of great help to the planners, decision-makers; agricultural advisers, farmers and other land users.

It may be pointed out that in Britain, no national level programme like that of Canada Land Inventory had been launched for land use planning. Based on U.S.D.A. land capability classification, the original eight classes was reduced to seven in Britain and the method was employed after some sort of modification (e.g. in the soil

surveys of Scotland, England and Wales). Sub-classes were defined quantitatively in Britain in comparison to the qualitative definitions in the American method. Moreover, more emphasis was laid on the limitations caused by the gradient and pattern of soil while employing the sub-classes (Mather, 1986). According to D. Mackney (1974), the main objectives of land use capability classification in Britain were (a) to simplify soil maps, (b) to provide basis for farm planning, and (c) to land use planning.

Accordingly, planners always tried to adopt the method of land use capability classification in development planning e.g. the development plan for the Island of Mull in the Scottish Highlands (Smith and Sutherland, 1974).

For land use planning purposes, land assessment was made by different persons / organisations. L. D Stamp's pioneering work on land use is noteworthy. From the 'Land Utilisation Survey in 1940s', the first national level assessment of land grade was made. Land was graded under this method primarily on the basis of land use characteristics and accordingly maps (1: 625,000) were published which assisted land use planning of 1950s (Stamp, 1962). Under the agencies of Agricultural Land Service of the Ministry of Agriculture, Fisheries and Food, a study group (1962) was established whose work in the heads of 'Agricultural Land Classification' was published in 1966. Land, under this scheme, was graded into 5 classes on the basis of limitations imposed by climatic conditions and soil characters on agriculture (Morgan, 1974). In case of general land use planning maps showing capability classes and sub-classes seems to be sufficient, but at more detailed planning levels, the levels of classification are not satisfactory. On the other hand, in case of agricultural planning subdivision of capability subclasses into units is essential for identifying land that can grow a similar range of crops, produce similar yields and can respond in the same way to management and improvement practices (Davidson, 1980).

It may, however, be pointed out that a basic weakness observed in the U.S.D.A. modelled land use capability classification method in Britain was its more orientation towards arable land which is not appropriately fitted in forestry or pastoral farming (Toleman, 1974). Thus, in U.S.A., Canada and Britain, the significance of land capability maps has widely been appreciated in land use planning (Davidson, 1980).

● 7.4.4.1.4 The Netherlands / Dutch Method

Land use planning in Netherlands was based on the soil-suitability system as the Dutch landscape is well known far intense use and under ever increasing pressure. Several studies were made for the assessment of soil/land suitability as well as for preparing soil maps towards effective land use planning. C. H. Edelman (1963) summarised the application of soil/land survey conducted in the '50s and recommended their use for growing crops, reclaiming land and for improvement. He gave little weightage to soil/land surveys in relation to town and country planning and particularly to the preservation of soils suitable for horticulture. Haans and Wesherveld (1970) emphasized on the use of soil/land data in the nonagricultural sector while reviewing the application of soil survey in the Netherlands.

A.P.A. Vink and E.J. Van Zuilen (1974) has defined soil suitability as 'the degree of success with which a crap or range of crops can be regularly grown on a certain soil, within the existing type of farming, under good

management, and under good conditions of parcellation and accessibility'. In Netherlands, soil suitability for arable and grassland has been assessed on the basis of soil maps at a scale 1: 200,000. The assessment was made qualitatively keeping in view the economic and technological situation of agriculture in and around 1960. In the following table, general soil suitability classification for arable and grassland has been made on the basis of soil maps of 1: 200,000 (Vink and Van Zuilen, 1967, 11974) :

Table 2 : General Soil Suitability Classification for Arable and Grassland

Major Class	*Soil Map Legend*	*CharacteristicsIUse Suitability*
Arable land and Grassland soils.	BG	Soils generally to arable land and to usually also to grassland. Subclasses are BGI, BG2 (2a. 2b). BG3, BG4, BG5, BG6, and BG7.
Grassland and Arable land soil.	GB	Soils generally suited to grassland and in many cases also to arable land. Subclasses are GB1. GB2. and GB3
Arable land soils.	B	Soils generally suited to arable land, but Mostly poorly or not suited to grassland. Subclasses are B1, B2, and B3.
Grassland soils.	G	Soils generally suited to grassland, but mostly poorly or I not suited to arable land. Sub-classes are GL G2. G3. G4. and G5.
Unsuitable soils.	O	Soils predominantly poorly suited to arable land and to grassland. Sub classes are 01, 02.
N.B.: Each major class has been divided into a number of subclasses on the basis of crop flexibility, gross production of grass, distribution of grass growth, bearing capacity of sod and fodder quality.		

Source : A.P.A Vink and E. J. Van Zuilen, 1974

It may be pointed out that the objective of the above-mentioned suitability scheme was to determine the degree of success in agricultural sector which could be expected to achieve through the management of different soils under specific conditions. The results of the scheme have been used for strategy formulation of land use planning but more detailed planning wants evaluation of maps of l: >0,000 or larger scale (Davidson, 1980).

For the effective planning purposes along with suitability, the study of limitations associated with each soil is necessary which can be possible only in the use of more detailed soil maps. In this direction Haans and Van Lynden (1978) and Haans (1978) stressed on the assessment factors in various land uses and the arising

limitations can be corrected by required measures accordingly. The table below shows the assessment factors and their use for various land use forms in Netherlands (Haans, 1978).

Table 3: Assessment Factors and their Use in Various Land Use Forms

Assessment Factor	*Land Use Form*				
	Arable	*Grassland*	*Forestry*	*Recreational*	*Low rise*
1. Drainage Status	+	+	+	+	+
2. Moisture Supply Capacity	+	+	+	+	
3. Bearing Capacity of Topsil		+		+	
4. Work Ability	+				
5. Structural Stability	+				
6. Bearing Capacity of sub-soil					+
7. Fertility Status			+		

Source : J. C. F. M. Haans, 1978

Soil assessment was done also for horticultural crops. W. J. Van Liere (1948) made an investigation into the effects of soil conditions on the root systems grown in green houses. It has been observed that the soils selected for horticulture seems to be suitable for field crops.

(n Netherlands, great importance was given on the selection of sites for settlements and accordingly urban planners have taken care of the nature of soils while proposing and development plan for the concerned area. For building constructions, main emphasis was laid on ground water level and bearing capacity (Stress and Strain). Similarly, the interpretation of soil survey information was applicable to engineering purposes.

In Netherlands, high standard of living generates recreational need and the country has already been saturated with intensive recreational pressure. In all types of land use planning the provisions and design of recreational areas are essentially considered. Soil information is very much helpful in the planning of many recreational areas. Mention must be made about the reclaimed polders for recreation with a range of facilities, such as, yachting, grassland, playground and forest walks.

H.N. Von Lier (1972) has identified three main problems viz. locational, capacity and lay out problems which need to be solved for recreational planning, He suggested that soil information can assist in locating suitable areas: (i) in predicting the maximum intensity of use without damage and (ii) in designing layout of the facilities. It may further be mentioned that land reclamation and rural development schemes were undertaken and modelled on the basis of soil survey work (Davidson, 1980).

● 7.4.4.1.5 F. A. O. Method

The New International System of Land Evaluation (Brinkman and Smyth, 1973) includes a new proposal for land classification on the basis of land evaluation system developed by a FAO (Wageningen, 1972). The essential aspects of this classification have been arranged at a number of levels, each of which has its own significance.

Land of undetermined suitability for the defined use has no place in the classification until such time as the suitability can be determined. The "order" of land suitability classification is highly significant because the decision must be taken depending on whether a particular tract of land is suitable or not for a specific utilisation purpose (see land capability classification in Unit-V).

● 7.4.4.1.6 Indian Method

The .4/1 India Soil and Land Use Survey Organisation (1970) introduced a scheme of land classification, modelled on the U. S D.A. method, to serve the land use planning objectives In this scheme, land is classified into two major categories viz. (1) Land suitable for cultivation (capability classes: I, II, III & IV) and (2) Land not suitable for cultivation (capability classes: V, VI, VII & VIII) (see Unit-V for detailed classification). Use suitability for each of the capability classes has been determined and the planning/management measures have been suggested accordingly.

▲ 7.4.4.2 Urban

The development of most urban areas is influenced, to some degree, by the processes of urban policy and urban planning. In the present context, the nature and operation of urban policy and planning in the UK, Europe and the USA from its origins in the nineteenth century until the present day would be examined (Pacione, 1992).

● 7.4.4.2.1 The United Kingdom

A primary objective of the UK planning system is 'to regulate the development and use of land in the public interest' (Department of the Environment 1999 p. 2). The aims of urban planning may be contradictory and reveal differing attitudes to the roles of the market mechanism and the state. Central to this debate, there is a question of 'planning for whom?'. While most of the purposes of planning assume that benefits should accrue to the 'public as a whole' or, in relation to redistribution aims, to the poorer and less vocal sections of the society, the question of the validity of these goals and the extent to which they are met has produced polarized views on the value of planning. The main goals planning are (Thornley; 1991):

"1. To improve the information available to the market for making its locational choices

2. To minimise the adverse 'neighbourhood effects' created by a market in land and development

3. To ensure the provision of any 'public goods', including infrastructure or actions that create a positive 'neighbourhood effect'. Which the market will not generate because such activity cannot be rewarded through the market

4. To ensure that short-term advantage does not jeopardize long-term community interest

5. To contribute to the co-ordination of resources and development in the interest of overall efficiency of land use

6. To balance competing interests in the use of land to ensure an overall outcome that is in the public interest

7. To create a good environment, for example in terms of landscape, layout or aesthetics of buildings, that would not result from market processes

8. To foster the creation of 'good' communities in tennis of social composition, scale or mix of development, and a range of services and facilities available

9. To ensure that the views of all groups are included in the decision-making processes regarding land and development

10. To ensure that development and land use are determined by people's needs not means

11. To influence locational decisions regarding land use and development in order to contribute to the redistribution of wealth in society"

For urban planning to exist, there must be a political consensus that the problems affecting cities can best be [hackled through government intervention. This, in turn, requires willingness by individuals to relinquish some of the rights to property which they enjoy in a free market and to accept the principle that land use should be centrally controlled for the public good (Cullingworth and Nadin, 1997; Ward, 1994; Chapman, Newman and Thornley, 1996). In general, the electorates in the UK and Europe have accepted the implications of a comprehensive system of urban planning; while in the USA government intervention in urban development is more restricted with zoning being the major mechanism for land use control.

The conservative alternative involved basic acceptance of the urban-industrial system but use of state intervention to ameliorate its worst excesses. It was the latter argument, articulated in the UK by the factory and sanitary reformers, and reinforced by the success of a number of early housing and new towns schemes, that paved the way for the emergence of modern urban planning (Cherry, 1988).

The social reformer and architect James Silk Buckingham (1849) proposed a utopian temperance community

of 10,000 to be named Victoria (Buckingham, 1849). The plan envisaged segregation of land uses with manufacturing trades and noxious land uses near the periphery as well as housing and offices in the inner areas. All dwellings were to have flush toilets and there would be a variety of house sizes to accommodate different households. Public baths were to be provided in each quarter of the town. A green bell of 4,000 ha (10,000 acres) of agricultural land would surround the settlement. All land was to be owned by the development company and buildings occupied for rent. Although Victoria was never built, many of the ideas were taken up by the later urban reformers, including Ebenezer Howard in his designs for garden cities.

● 7.4.4.2.2 Western Europe

In parallel with the development of utopian idealism in Britain, equally ambitious alternative urban forms were being advanced in Europe in the ideas of the Italian Futurist movement, launched in a manifesto by Marinetti in 1909. The concept of a new, comprehensively planned city was a key idea in futuristic urban designs_ which included high-rise building, elevated roadways, land-use segregation and the use of mass production techniques and new materials such as glass and concrete. The concept of high-rise, high-density building was translated into practice in most of the large cities during 1950s and 1960s, although in many instances less attention was given to the quality of space surrounding the tower blocks. Notwithstanding differing national circumstances, three broad phases of urban planning in Western Europe can be identified (Pacione, 1992):

1. In the immediate aftermath of the Second World War the focus of attention was on reconstruction and satisfying the backlog of housing and basic infrastructure.
2. By the late 1950s, increasing affluence and the growth of centralized planning systems led to comprehensive shun clearance, city centre redevelopment schemes, and construction of urban motor ways and large-scale public housing projects.
3. From the late 1970s, growing awareness of the of the social disruption caused by the large-scale remodeling of cities led to greater attention to public participation in planning, and the replacement of redevelopment by rehabilitation

● 7.4.4.2.3 The USA

Although urban planning in the USA shares the same reformist roots as in the UK, its evolution and temporary structure are very different. In contrast with Britain, there is no national system of planning in the sense of a common framework with a clearly defined set of physical, social and economic objectives.

In principle a range of techniques for controlling urban growth and land use are available, but in practice the major tool employed< is land use zoning. Specific urban problems, such as provision of low-income housing, are addressed through federal policy.

The first comprehensive zoning ordinance was passed in New York in 1916. The Judgement of the US Supreme

Court in 1996 that zoning did not infringe the 14th Amendment to the Constitution (which protects against property being taken without due process of law) led to widespread adoption of the technique Under this, procedure, the effective control of land use was transferred from the state to the municipalities and townships, which were thereafter permitted to limit the types of development on land within their boundaries (Nelson, 1080), including control over the height, bulk and area of buildings of zoning regulations. The purposes of such controls were to (i) minimise problem of congestion. fire hazard, shading by high buildings; (ii) control population density; (iii) ensure provision of urban and (iv) promote general welfare of the public. In practice, there are many common forms of land use, zoning (Weaver and Babcock, 1979; Jackson, 1981).

Common Forms of Land Use Zoning in the USA : Zoning is the division of an area zones within which uses are permitted as set out in the zoning ordinance. If, however, owing to special circumstances, literal enforcement of the ordinance will result in unnecessary hardship for the landowner, the board of adjustment is empowered to issue a variance or relaxation of zoning conditions. The zoning system is, therefore, characterised by a number of forms of zoning including the following (table 4):

Table 9 : Common Forms of Land Use Zoning and their Characteristic Features in USA

No. of Zoning	*Forms of Zoning*	*Characteristic Features*
1.	Cluster zoning and planned unit development	This involves the clustering of development on part of a site. leaving the remainder for open space, recreation, atnenity or preservation. The planned unit development is an extension of cluster zoning in which developers are given freedom to design developments to meet market demand but within a negotiated set of criteria relating to pollution, traffic congestion etc.
2.	Special district zoning	This is designed to maintain the special land use character of a place, such as the Special Garment Center District in New York City, designated to deflect market forces and maintain the garment industry against pressure to convert manufacturing space into offices and apartments.
3.	Downzoning	Downzoning is the rezoning of an area to a lower density use and is often the result of neighbourhood pressure to avoid development of an intrusive land use Since Downzoning is likely to reduce the value of undeveloped land, it is likely to be objected to by the landowners.

No. of Zoning	*Forms of Zoning*	*Characteristic Features*
4.	Large lot zoning	This has the ostensible purpose of safeguarding public welfare by ensuring that there is good access for emergency-service vehicles. roads are not too congested, and there is ample open space. It can also be employed to exclude undesirable residential development and maintain the social exclusivity of a neighbourhood.
5.	Incentive zoning	This is basically a means of obtaining private-sector provision of public amenities by offering zoning bonuses in return for private finance of specific infrastructure. It is similar in principle to the t.rK concept of 'planning gain'.

Source : C. Weaver and R. Babcock, 1979; R. Jackson. 1981

● 7.4.4.2.4 India

During the first six decades of the 20th Century, Indian cities became irregularly, but substantially more even in relative size. Since 1961 the cities have become slightly, but steadily more unequal (Mills and Backer, 1986).

The metropolis does not stand in isolation like an island from the rest of the region. Rather it is interspersed with smaller urban centres, which gradually grades into a peripheral landscape. Besides, a strong interaction exists between the metropolitan city and the immediate neighbourhood. This zone of interaction, which may be called the metropolitan zone of influence, is a closely integrated region and consists not only of metropolitan city but also a constellation of hamlets, villages and towns which are interoven into the web of metropolitan life. On the basis of waning interaction of the city with its neighbourhood with increase in distance, the metropolitan regional land use zones of Delhi are as follows (Nangia, 1976):

Table 5 : Metropolitan Land Use Zones of Delhi

No. Zones	*Types of Zones*	*Characteristic Features*
1.	City Area	It consists of the city proper and its immediate neighbourhood which has nearly become a part of the 'Extended urban-life'
2.	Rural-Urban Fringe	This zone lies immediately outside the city area and has strong interaction with the city proper in terms of daily commutation, exchange of goods and services and bears an urban reflection on the physical,

No. Zones	*Types of Zones*	*Characteristic Features*
		occupational and demographic structure. It is rural compared to the typical urban of the city area and urban compared to the typical rural landscape.
3	Peripheral Rural Area	This zone extends beyond the rural-urban fringe. It is not a completely rural landscape as may be inferred from the title but is interspersed by pockets of urban settlements and their zones of influence. Of the three zones, this zone has the least interaction with the city.

Source : Sudesh Nangia, 1976

The metropolitan zone of influence may thus be stated to be extending up to the outer boundary of rural urban fringe.

The experience of Metropolitan Planning in Delhi has illustrated that dispersion of activities and population away from an overcrowded metropolis can be planned in two ways as given below (Ray Chaudhuri, 2001)

1. Development of satellite towns at short distances from the metropolitan core, within the metropolitan area immediately surrounding the metropolis may be planned. Such towns, owing to their closer location to the metropolitan core, would be dependent on the metropolis for successful economic and social functioning. This concept is similar to the development of the Salt Lake City or Lake Town near Calcutta.

2. Another way is the development of smaller regional urban centres (or New Towns like the British new Towns) at suitable location at considerable distances from the metropolitan core, but within the larger metropolitan region so that they can function independently. This concept is similar to the plan of developing Durgapur in West Bengal as a counter magnet to Calcutta.

■ 7.4.5 LET US SUM UP

In the present world situation, land use planning is considered the only panacea. To meet the demands of increasing population every inch of land is to be utilised properly. Thus, planning of land use differs in developed and developing countries according to their need and infrastructure.

In the developing countries, plans and programmes are to be implemented keeping in mind the food problems and other basic needs. Obviously, the prime objective of such countries is to plan the agricultural land use as well as to encourage rural development. Moreover, the misuse and under-use of land are to be prevented.

In the developed economy, on the other hand, emphasis should be given in the planning of urban land use. Besides, over-use of land is one of the phenomena in the developed countries. In addition to the above

mentioned methods of land use capability assessment, remote sensing techniques may be used for effective land use planning in the developing countries.

Finally, whatever may be the methodologies adopted for rural and urban, land use planning is necessary in both the developed and developing countries for sustainable development of soil and land resources.

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7.4.7 SELF ASSESSMENT QUESTIONS / EXERCISE

1. What are the factors on which the survey of land use depends?

   Your answer should include the following points :

   - Purpose
   - Scale of map
   - Nature of the area to be surveyed

2. Which aspects Cadastral Survey provides?

   Your answer should include the following point :

   - Ownership aspects
   - Institutional aspects of land use

3. Mention the three levels of land classification structure which USDA provides.

   Your answer should include the following points :

   - Capability Class
   - Capability Sub-Class
   - Capability Unit

4. The Canadian Land Capability Scheme has been modelled on which method?

   Your answer shoul include the followin point :

   - U.S.D.A. method

5. What are the main objectives of land use capability classification in Britain?

   Your answer should include the following points :

- To simplify soil maps
- To provide basis for farm planning
- to land use planning

6. What are the two major categories of land use as proposed by AIS & LSO?

Your answer should include the following points :

- Land suitable for cultivation
- Land not suitable for cultivation

7. What are the common forms of land use zoning in USA?

Your answer should include the following points :

- Cluster zoning and planned unit development
- Special district zoning
- Downzoning
- Large lot zoning
- Incentive zoning

8. Mention the land use zones of Delhi as proposed by Sudesh Nangia.

Your answer should include the following points :

- City Area
- Rural-Urban Fringe
- Peripheral Rural Area

7.4.8 SUGGESTED FURTHER READINGS

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M.A./M.Sc. PART – I
Paper - IV : Module - VII
Unit - 05

Module Structure

- 7.5.0 INTRODUCTION
- 7.5.1 OBJECTIVES
- 7.5.2 CAPABILITY CLASSIFICATION
- 7.5.3 ENVIRONMENTAL IMPACTS OF LANDUSE CHANGES
- 7.5.4 ENVIRONMENTAL IMPACTS OF LANDUSE CHANGES LAND USE PLANNING IN INDIA
- 7.5.5 SELF ASSESSMENT QUESTIONS
- 7.5.6 SELECTED REFERENCES

M.A./M.Sc. Part - I

PAPER - IV, MODULE - VII

Unit – 05

■ 7.5.0 INTRODUCTION

Land utilization is the conversion of land from one major use to another general use. The study of land use is an urgent need for resource planning cultural advancement as well as overall economic development of a nation. Several factors are responsible for land use pattern. Among the physical factors geology, relief, drainage, climate, soil, vegetation etc take part in land use planning; whereas the human factors like socio-economic and institutional factors influence the land use policies of a nation.

The types of land use depend mainly on three basic factors i.e., nature of environment, nature of development and types of practice. The quality of land is more or less controlled by soil and for this reason soil is treated as determinant of land use. According to Graham thoughtful management is necessary in order to maintain desired production as well as to provide essential domestic needs to the people and to accelerate foreign trade.

■ 7.5.1 OBJECTIVES

Following objectives of land use studies are categorized in this way—

a) Land is the product of nature and that should be utilized by man very carefully to prevent its quality or productivity.

b) The increasing rate of population pressure may degrade the land quality by unscientific uses.

c) The scientific uses of land can protect its sustainability.

d) There are various impacts of land use changes resulted from natural processes and uncontrolled human activities

■ 7.5.2 CAPABILITY CLASSIFICATION :

Broadly speaking "Land Capability" means productive potentiality and ability of land. It generally refers to as an expression of all environmental parameters as applied to the biological potential of a specific unit of land at a given time. Land capability changes with time and space.

A tract, for example, may be good for the time-being but may not maintain the same in future due to adverse environmental situations. The capability of land deteriorates with soil erosion, but increase with the addition of sites because of flooding. A land capable of producing rice may not have the capability of producing wheat because of situation. The hard basement has the capability for establishing industries but could not have the capability of producing crops.

Land capability classification is an exercise for interpretative grouping and grading of soils according to their potentialities and limitations. It helps to organize significant soil factors for conservation (Stallings, 1957).

In classifying land into different capability groups various factors are generally considered. These factors are Viz : (i) the external land features like topography, angle of slope, drainage, stoniness etc. (ii) the inherent soil characters and (iii) the degree of limitations in the use of land arising out of above land feature and other environmental factors. Besides, susceptibility to erosion, degree of slope, depth of water table, wetness, water logging, climatic hazards, nature of subsoil, soil reaction, depth of soil etc. are taken into accounts which are responsible for limiting the productive capacity. (Sharma *et.al.,* 1980).

Objectives of Land Capability Classification :

Land capability classification is a scientific appraisal of the physical characters of the land, inherent soil qualities and management practices. The main objective of land capability classification is to understand potentiality, capability and suitability for the optimum utilization of land. According to M.S.V. Rama Rao, the general purpose of land capability classification is to provide a systematic basis for the study of crop and soil relationship so as to increase the productivity of land by various means. There is a need for such studies because per capita supporting capacity of land is decreasing with increasing population. Land capability measurement offers a scientific judgement for the conservation of land under specific ecological conditions.

Land capability is one hand helps to find out efficiency of land for particular uses and on the other it helps to prevent improper use of land which leads to erosion hazards and deterioration of land quality. So, for the sake of optimum productivity, the capability of each and every bit of land should be measured considering its inherent pedogeomorphic characters

as well as limitations due to environmental hazards. Besides, capability classification enables the farmers to use the land properly for sustainable production under required management measures.

Methods of Land Capability Classification :

Land capability classification is essential for the planning of agricultural development. Land use capability classification (Klingebiel and Montgometry 1961, Bibby and Mackney, 1969) has been developed with an objective to express the influence of site, soil and climate on farming. Soil information is essential for capability classification which is obtained by field experiments. Land capability is assessed on the basis of knowledge of the behaviour of soil types along with the influence of gradient and climate, management and crop response as well as from the experience and research.

Land classification is an important method of organising the available knowledge and information about soil and other environmental factors. There are different ways and means of land classification for different purposes by various scientists. An attempt to use land without assessing its resource potentialities may cause economic failure and permanent impoverishment of natural resources. Hence, the nature of resource potentialities should carefully be studied and an assessment is to be made on the suitability of the land for various kinds of use.

Sharma (1972) defines land capability classification as "a field investigation of soil properties, slope, degree of soil erosion and changing land use pattern which form the basis for future planning of soil and water conservation".

There are several methods of land capability classification such as land capability classifications of the U.S. Soil Conservation Service; U.S. Dept. of Agriculture, U.S. National Resource Planning Board; U.S. Bureau of Reclamation; L.D. Stamp's land classification in Britain; Cornell system of economic land classification; Land use capability classification of Iraq; Northern Ireland system of land classification; Land classification of U.S.S.R.; Japan; China; Land capability classifications by A.I.S.L.S.O., I.C.A.R. etc.; land capability classifications based on environmental and geomorphic attributes, land complex approach, landscape ecology; land capability classifications after Nelson, Azzi, Storie etc.

AIS & LSO (1970) :

The All India Soil and Land use Survey Organisation (AIS & LSO) Land Classification Scheme is as follows :

Land Capability Classification after AIS & LSO, 1970

Major category	Capability classes	Characteristics	Land quality and preventive measures
Land suitable for cultivation	Class-I	Level, valley land, deep productive soil.	No special difficulty in farming. Suitable for intensive cultivation. Very good cultivable land.
	Class-II	Gentle slope with good soil, subject to water or wind erosion, minor soil problems.	Good cultivable land : Cultivation with precaution and management. Needs improvement of drainage, conservation of irrigation water and protection from erosion or floods.
	Class-III	Good soil with moderate slopes, subject to water and wind erosion.	Moderately good cultivable land. Cultivation with precaution and careful management. Special attention on intensive drainage, erosion control, protection from floods and conservation of irrigation water.
Major category	**Capability classes**	**Characteristics**	**Land quality and preventive measures**
Land suitable for cultivation	Class-IV	Moderately steep land with fairly good but shallow soil with gravels, stones locally; subject to serious water and wind erosion.	Fairly good land. This land class is suited for limited or occasional cultivation in rotation, special summer crops cultivation in wet years. Needs intensive drainage, intensive control of erosion and very intensive measures to overcome soil limitations.
	Class-V	Good, productive, wet mountain meadows.	Very well suited for grazing, not suitable for arable farming, grazing and wild hay suitable. Needs protection from gully erosion.
	Class-VI	Steep land, flat to gently sloping land. Shallow soils with stones and gravels.	Well suited for grazing or forestry. Not suitable for arable farming. Management in grazing and forestry and conservation of soil and moisture are essential.

	Class-VII	Very steep land, flat land with very shallow stony soil, subject to erosion.	Fairly well suited for grazing or forestry. Not suitable for arable farming. Careful management in grazing and forestry.
	Class-VIII	Highly erodible gullies, badlands, dunes, tidal flats and swamps, barren mountain tops.	Suited only for wild life, recreational facilities and protection of water supplies and maximum erosion.

It is apparent that the classification as shown above has very much relevance in the assessment of land productivity. In this classification, emphasis has been laid on the limitations in land and soils for agricultural land use which is more or less based on the scheme of U.S.D.A.

Land Capability Classification : Environmental Approach

In this approach land capability is assessed by taking into account the overall environmental attributes. The environmental attributes generally include : (i) physical attributes land, water, soil, climate, vegetation etc. (ii) human attributes – human desire, skill, knowledge, technological level of man etc. (iii) environmental hazards (both natural and man induced) flood, drought erosion, cyclones, deforestation, pollution etc.

Generally a fertile soil with available water may have the ability to produce huge crops, but it lacks in technology and other facilities and is affected by recurrent flood, drought, erosion and other kinds of environmental hazards, the degree of capability decreases. Therefore, not only the physical attributes but also human environmental attributes as well as the associated hazards are to be considered in assessing the degree of land capability.

■ 7.5.3 ENVIRONMENTAL IMPACTS OF LANDUSE CHANGES :

Problems of Land use :

There are innumerable (natural as well as man induced) problems which may affect land use in a particular area.

The major problems affecting land use directly or indirectly are as follows :

a) **Soil Erosion** : Soil erosion is a comprehensive process of wearing down of loosened land surface through natural agents such as running water, ground water, sea waves, glaciers,

wind etc. Broadly speaking, there are two types of soil erosion i.e. (a) soil erosion by natural agents and (b) man induced soil erosion.

Natural soil erosion is common almost everywhere whether humid, or arid/semi-arid. Soil is removed by the natural agents (water, wind, glacier etc.) in almost every parts of the world. Sometimes, negligible amount of finer soil or colloids also move down within the soil profile and are deposited in the lower horizon.

During heavy down pours soil erosion reaches its maximum. Water erosion is mostly severe during rainy season and erosion by wind gets momentum in dry month. Soil erosion by rain has three harmful effects i.e. (i) it detaches the soil, (ii) its beating effect destroys granulations and (iii) its splash displaces soil.

Soil erosion through gullies is most harmful to land utilization. In India nearly 6 million hectares of land are affected by gullies and ravines. The areas which are intensely damaged by gully erosion are 'chos' of northern Haryana and Punjab as well as badlands of Madhya Pradesh and Uttar Pradesh.

Besides natural erosion, intensive human activities lead to severe erosion. Due to compaction, smearing, excessive working, pulverization etc. through human activities fertile upper soil layer are removed faster. As a result, soil organic matter declines and consequently physico-chemical properties of soils are changed. Man-induced soil erosion is mostly common in the humid tropics as extensive forest clearance, removal of grassland and extensive overgrazing for livestock are practiced at an alarming rate. However, soil erosion whether natural or man-induced affect the scale of use of land.

b) **River Bank Erosion :** The rivers by nature actively erode their banks. They change their courses by eroding one bank and depositing the eroded materials to the other. Generally stream bank erosion gets momentum during rainy season when discharge of water in channel bed increases. For example, the Koshi river in India has changed its course westward by about 100 km. Most of the Indian rivers flowing through the Great Plains are often engaged in stream-bank erosion. The river bank erosion affects land use by damaging crop fields, settlement sites, soil as well as natural vegetation.

c) **Sea Shore Erosion :** This type of erosion is caused through the striking effects of strong sea-waves. The strong tidal effects and ingress of saline water create havoc to the coastal vegetation and other land uses. For example, the Kerala coast in India is the most affected zone (out of the 600 km about 300 km has been threatened by sea-shore erosion).

d) **Leaching :** Leaching is a process by which soluble materials such as mineral salts and organic matter are washed out from the upper layer of soil into the lower horizon by percolating rainwater. High temperature and heavy downpours favour the degree of decomposition of rocks which causes thorough leaching within the soil profile. As a result, the bases are leached out easily. For example, in the lateritic areas of the tropical region leaching is predominant. Heavy leaching arising out of high rainfall accelerates the process of humification and mineralizations which keep the surface low in organic matter thereby land use is affected.

e) **Deforestation :** Deforestation creates problems in regard to land use through increased rate of soil erosion, addition of sediment load in the rivers, siltation in the channel beds and reservoirs, frequent flooding and drought, intensification of green house effects, destructive force of atmospheric storms, reduction of agricultural production due to loss of fertile top soils, decrease in fodder production etc.

f) **Excessive Use of Irrigation Water :** Excessive use of irrigation water ultimately becomes harmful to agricultural land use. Due to over-extraction, underground water table is dwindled down, capillary action is disturbed and structure of surface soil is affected. Continuous use of irrigation water gives rise to water logging and salinity increases gradually.

It has been observed that canal irrigation results in salt incrustation on the surface soil. Sometimes this system helps weeds to grow on cropland in bringing water table closer to the surface. Sometimes it also causes problem of water logging.

g) **Bad Effect of Commercial Fertilisers :** It is true that in areas of permanent agriculture crop production is enhanced by the application of commercial fertilizer initially and subsequently the principle of the law of diminishing return is met with. The regular use of commercial fertilizer deteriorates the physico-chemical conditions of soil and ultimately the land productivity decreases. Moreover, the plants and crops are infested with diseases and the tastes and quality of crops deteriorates.

The productivity of land is definitely increased temporarily because of the overdoses of chemical fertilizers, but unfortunately fertility decreases in the long run mainly due to loss of organic matter. According to Prof. W.B. Bollen, more crops are produced in U.S.A. but lands are losing fertility.

h) **Bad effect of Pesticides :** Use of pesticides deteriorates the quality of land use through the contamination of air, water and soil. The direct consequences arising out of pesticide persistence on land are as follows :

--- When pesticides are exposed to environment, these not only destroy the harmful insects but also destroy the microbes beneficial to the plants.

--- Nitrogen enriched green foliage of plant tissues attract the insects. Due to the lower intensity of solar energy during winter, blight and other crop diseases are caused.

--- Pesticide residues on plant tissues / leaves / soil undergo photo-chemical reaction under broad daylight and thereby cause photo-toxicity. As a result, healthy photo-synthesis is retarded.

--- Pesticides hinder the microbial activity in the soil, so that the organic matter synthesis is hampered. The humus formation in soil, as a result, becomes impossible. Consequently, soil suffers from prolonged nutrient deficiency.

i) **Flood Hazards :** Flood is an attribute of physical environment and acts as both soil depositing and soil eroding factor. It promotes washing away of surface soils by its great force leading to soil degradation. Flood is a natural as well as man-induced phenomenon which causes severe erosion and total crop damage. For example, in India, a considerable area is flooded which significantly affects its land use.

j) **Drought Hazards :** Any type of land use practice needs water. Drought is an environmental hazard which reflects deficiency of water in a particular region. It may be mentioned that prolonged dryness causes drought conditions which depend on the amount of rainfall, its departure from the normal annual average, and demand of water for multipurpose uses. Drought poses a serious bearing in the biospheric system. The cumulative effect of

prolonged drought causes extensive and enormous damage to natural vegetation and agriculture. Thus, deficiency of water hinders optimum utilization of land.

In India, the chronically drought-affected areas include sixty seven districts of which 25 per cent of the total cropland is affected. The severely drought affected areas include whole of Rajasthan and Gujarat; Western and south-western parts of Punjab, most of Haryana, south-western parts of U.P. narrow strip along the western, and north-western border of M.P., rain shadow areas of Western Ghats, other scattered pockets like palamau district of Bihar, Bankura and Purulia districts of West Bengal, Kalahandi region of Orissa etc.

k) **Cyclonic Hazards :** Cyclone is one of the most powerful and destructive atmospheric hazards which cause severe damage to land use. The destructive tropical cyclones and other local storms damage buildings, disrupt communication systems; destroy agricultural crops, domestic and wild animals, natural vegetation and so on. Thus these exert a serious blow in the trend of land utilization pattern though temporarily. In Bangladesh, for example, for example, the tropical cyclone (17^{th} November, 1970) results in crop losses which is amounted to 63 million U.S. dollar. The damage of crops of tropical cyclone in the coastal areas of India is a regular phenomenon.

The other atmospheric hazards such as fog, sleet hailstorm etc. also cause severe crop damage.

l) **Impact of Mining :** Mining operations are responsible for land degradation and damage to the adjacent agricultural lands. Subsidence due to mining operations not only affects the extracted tunnels but also the unextracted surrounding areas. For example, the problems of land subsidence in the Raniganj coal belt have reached to an alarming state. In the fast expanding Raniganj belt underground coal mining has resulted in land subsidence over a total area of 30 sq.km. in different parts of the locality. The subsided areas associated with large number of cracks, caves in, abandoned pits and shallow manual quarries are now lying as fallow lands. As per 'Statesman' (15^{th} December, 1985), the subsidence of land severely affects the area almost in every week and causes panic to thousands of people in the coal bearing areas of West Bengal.

Severe land subsidence occurred in Mahabir Colliery near Raniganj township in May and November 1985 and in February 1986. In 1985, the nearby area of Sitarampur Railway Station was also affected by subsidence. Further on 31st March, 1986 an area about seven km away from the Girmint Colliery, was subsided. Besides the extracted open pits, soil erosion is very much prevalent in all mines.

m) **Impact of Industrial Wastes :** Though industries contribute a lot to the economic development of a society, yet there are numerous unto ward incidences and undesired output from the factories such as industrial wastes, toxic gases, chemical precipitates, ashes, smokes, polluted water etc. which directly or indirectly hinder the utilization of land. The exposure of toxic substances to environment through application of the output of chemical industries (i.e. fertilizers pesticides and insecticides) changes the hierarchy of food chains and food webs as well as physical and chemical properties of soil. The productivity of land is significantly decreased due to acid rains, which destroy mineral elements and other soil nutrients. In U.S.A. Germany, Canada etc. forests have largely been damaged due to acid rains.

n) **Effect of Fragmented Holdings :** Fragmentation of holding is a great obstacle and one of the major constraints to agriculture. It experiences a number of problems especially to agricultural land use such as difficulties in cultivating fragmented scattered plots, wastes of land for multiple boundaries, raising the cost of agricultural production, difficulty in irrigation development and in the use of modern farm machinery etc. It may be pointed out that in India, the principle of equal sharing among heirs are responsible for the repeated fragmentation of holdings which badly affects land use to a great extent.

o) **Other Natural Hazards :** The other natural hazards affecting land use include earthquakes, volcanic eruptions, tsunamis, tornadoes, sand dunes, sand hills coastal and desertic areas etc.

p) **Unfavourable Administrative Policy Management Practices :** Administrative policies and management practices have a significant impact in land use development. If a land use policy does not take into account the landscape ecological aspects, it is bound to give negative results ultimately.

■ 7.5.4 ENVIRONMENTAL IMPACTS OF LANDUSE CHANGES LAND USE PLANNING IN INDIA :

Concept :

A dictionary definition of planning is the process of placing action into a particular order to achieve an objective. All areas of human activity have an element of planning within them. Perhaps, the most widely understood use of the term "Planning" refers to land use planning.

An ideal definition was given by Prof. L.D. Stamp – "Land Planning is in essence the determination of the optimum use of every acre of land which must be elastic and can change from time to time to adopt the changing conditions". This optimum use of land changes with time and space keeping in view the existing economic set-up.

It may further be pointed out that land planning in essence, is the right and balanced allocation of land between rival claimants. (The land in the over-populated countries can no longer produce sufficient food to support their population. However, the planner's task is always to determine the optimum use of every bit of land (which to some extent can serve more than one purpose and multiple use of land can be promoted wherever possible) in the national interest. Land use planning should be based on the specific objective, detailed survey and assessment of the present position of land of the concerned area. Thus, the basic needs (work, home, food, recreation, communication and security) of manking can be satisfied only with appropriate land use practices (Stamp, 1967). According to J. N. Jackson (1963), "Land use planning is more than a compound of architecture, engineering, public administration and social sciences. It is a new engineering discipline with its own scientific and objective approach to its central theme, the use and development of land".

Objective :

The objectives of land use planning may be outlined as follows :

1) To determine the optimum use of every bit of land.

2) To prevent the over use, misuse and under use of land.

3) To identify vacant land, degraded land, marshy land, unirrigated land, dry land, waste land, infertile land and to suggest necessary measures.

4) To measure and determine the inherent characteristics of land of an area concerned.

5) To maintain land capability.

6) To promote optimum agricultural growth.

7) To carry out balanced regional development.

8) To protect productive land from the hazards as much as possible.

9) To suggest appropriate use of land i.e. choice between alternatives.

10) To prescribe land utilization measures which varies from place to place depending on the requirements.

Land use planning is essential to carry the burden of ever increasing population, especially, in the developing countries. However, the land-use planning methodologies adopted in developed and developing countries and diverse because of their circumstantial differences/differences in physical outlook and need of the society. It should be mentioned in this context that land use planning is related to land capability assessment. Planning of land use can be done only after proper assessment of land capability.

Indian Method :

The All India Soil and Land Use Survey Organisation (1970) introduced a scheme of land classification, modeled on the U.S.D.A. method, to serve the land use planning objectives. In this scheme, land is classified into two major categories viz. 1) Land suitable for cultivation (capability classes : I, II, III & IV) and 2) Land not suitable for cultivation (capability classes : V, VI, VII & VIII). Use suitability for each of the capability classes has been determined and the planning / management measures have been suggested accordingly.

Environment Approach :

In this approach, the capability of land is assessed by taking into account the overall environmental attributes (De & Jana, 1994). The environmental attributes here include (i) Physical attributes (i.e. land, water soil, climate, vegetation etc.), (ii) Human attributes (i.e. human desire, skill, knowledge, technological level etc.), and (iii) Environmental hazards (i.e.

flood, drought, erosion, cyclones, acid rain etc.). After having the land classification, future land uses are recommended and accordingly measures are suggested for each of the capability classes.

Geomorphological Approach :

The land use is the result of interaction of geomorphic and socio-economic factors. This is true on macro as well as micro regional scales. However, land use in mountains, plateaus and plains differ greatly. Similarly, scraps, pediments, valley flanks, flood-plains, ridges and basins affect the types of land use. Micro-regional landforms like alluvial cones and fans, drumlins or eskars, monad nocks, levees, sand dunes, and oasis are marked by different land uses. The geomorphology sets the foundation and background of land use, whether it is glacial / arid / karst / coastal / volcanic region and or whatever it may be. Based on the geomorphological attributes (i.e. lithology, parent material, relief, slope, drainage, soil, vegetation, erosional and depositional processes etc.) the land capability assessment of a given area is made and hence classified. Future land uses are proposed and subsequent measures are suggested for each of the capability classes for optimum utilization. It may further be pointed out that the planning strategies for an effective land use may be executed properly if the concerned area is accessible which is mainly controlled by the geomorphological characters (e.g. for the development of transport accessible region is essential).

Concluding Remarks :

In the present world situation, land use planning is considered the only panacea. To meet the demands of increasing population every inch of land is to be utilized properly. Thus, planning of land use differs in developed and developing countries according to their need and infrastructure.

In the developing countries, plans and programmes are to be implemented keeping in mind the food problems and other basic needs. Obviously, the prime objective of such countries is to plan the agricultural land use as well as to encourage rural development. Moreover, the mis – use and under-use of land are to be prevented.

■ 7.5.5 SELF ASSESSMENT QUESTIONS

1. **What is Land Capability? Describe the methods of land capability classification.**
2. **What are objectives of Land Capability classification? Explain the environmental approach of Land Capability classification.**
3. **Explain the environmental impacts of Land use changes.**
4. **Describe the various methods of Land use planning in India.**

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■ 8.1.0 INTRODUCTION

Resource relates to man and it is functional. It is only means to an end, the end being satisfaction of human wants or social objectives. A thing is resource so far as it affects man as a means of satisfying his wants. That is to say a thing becomes resource by its function in relation to man. A lump of coal is resource, neither because of its shape, colour or composition nor for its scarcity but because it functions for satisfying some human want. To a prehistoric man the vast deposits of minerals underground, e.g., coal, petroleum, iron ore, etc. were known. He did not know their uses. These natural things affected him neither favourably nor unfavourably. To him they were not resources. But to a modern man they were doing miracles. They function for his benefit and for satisfying his wants. To him they are resources. Thus resource is something functional. It refers the function that a thing (material or non-material) performs. But mere function is not enough. The end result of the function must be beneficial to man. This functional or operational aspect of resource is of paramount importance.

In recent years, the study of resource has been developing as a distinctly separate subject which attempts to collect data from various branches of knowledge such as, geography, geology, history, economics, sociology, politics, science and technology. In short, one has to travel over a wide range of subjects and make out a synthesis. This is particularly because 'culture has the widest horizon and it is the most vital factor in modern development of resources.

■ 8.1.1 KEY WORDS: Resource, Creation, Classification, Management, Sustainability

■ 8.1.2 OBJECTIVES

- The aim of the subject is the proper understanding of functions and operations of resources.
- Now-a-days every nation or every country shows keen concern for resources within its political boundary. Every country plans to develop her resources.
- The study of resources helps one to know the nature, behavior and functions of basic resources, viz., natural resources, human resources and cultural resources and to plan for their proper use and development.
- The study of resource is also important to have a clear and fuller view about economic life and activities of human being in different parts of the world.
- Moreover, in this world of population explosion, the best use of resources is or at least should be the basis of all economic activities. It requires a sound understanding of the nature of regional resources.

The goal of resource-study is to contribute effectively towards such understanding.

- The study of this subject should help students to become more efficient workers in the economic realm. It should enable him to meet more intelligently the social problems of this age.

■ 8.1.3 MEANING AND NATURE OF RESOURCE

The word 'resource' means something of value of usefulness. In the early days, this value generally meant 'valuable'. Since economic value increases with scarcity, only the scare commodities or substances were considered as resources. But in the modern world, resource means something which is function able in relation to human demand. A resource is any physical or virtual entity of limited availability, or anything used to help one earn a living. In most cases, commercial or even ethic factors require resource allocation through resource management.

The terms 'resource' had no special significance till the early part of the twentieth century. Only in 1933, when the eminent professors of economics Erich W. Zimmermann promulgated his famous "Concept of Resource", the idea became so popular that numerous articles and papers started pouring in the contemporary Economic Geographical literature.

■ 8.1.4 DEFINATION OF RESOURCE

- *Zimmermann's definition (1933):* According to the definition given by E. W. Zimmermann, the word 'Resource' does not refer to a thing or a substance but to a function which a thing or a substance may perform or to an operation in which it may take part, namely, the function or operation of attaining a given end such as satisfying a want. For example, the existence of petroleum is not considered as a resource, but its function ability in relation to the human demand is considered as a resource.
- *Earth Summit Resolution (1992):* Earth Summit held at Rio- De- Janeiro in 1992 resolved that anything which may have some function not only to satisfy human demand at a given end but also to ensure preservation of biosphere should be considered as resource.

■ 8.1.5 CONCEPT RESOURCE

Old concept: There is great controversary about the meaning and definition of resources. The exponent of old and static school hold that natural phenomena are all resources.

(i) They are already in the realm of nature and are fixed or static.

(ii) Resources are not made or created. Man by his intelligence and skill, has simply developed some of those (natural) resources making them suitable for human use and the rest of the (natural) resources are still left undeveloped. To these old schools of thinkers resource means nature. Natural things good or bad, effective or ineffective are all resources. To them the hydro-electric potentiality of the Congo river and the coniferous forest belt on the higher slopes of the Himalayas are all resources; even though, there is little chance

of these being used under the present socio-economic condition of the countries concerned. This view about resources without any reference to their functional aspects is not acceptable to modern thinkers.

Modern concept: Prof. Zimmermann and other supporters of modern school hold that resources being human welfare.

i) Natural phenomena are not all beneficial to man. In nature there are floods, earthquakes, storms, poisons, etc.which hinder human progress and welfare. These cannot be treated as resources.

ii) Resources are not confined to nature alone. There are human resources and cultural resources as well. A healthy society, scientific knowledge, technological skill etc. can bring welfare to man and are certainly resources.

iii) The most significant specialty of the modern thinkers is that, they believe in the functional theory of resource, which entails that:

(a) Resource is functional and operational.

(b) It is made or created by efforts of man, and

(c) It is dynamic and not static.

- **MODERN ECONOMIC APPROACH OF RESOURCE STUDY**

MAN AND RESOURCE: A study of economic activities is, in fact, a study of man in relation to resources. By agriculture man produces crops by fishing he gets fish, by cutting forest trees he derives timber, by mining he gets minerals and by manufacturing he gets host of useful articles. All these are resource derived from various types of economic activities. Through transportation and trade again, these resources are placed where they are most wanted. In fact, the aims and effects of all economic activities are either development of resources or their utilization. In a study of economic activities one actually studies man and his resource. In other words, economic activities are only resource- building and resource- utilization activities of man.

NATURE-MAN-CULTURE: All the activities are not uniform in different parts of the world. There are innumerable diversities and there are similarities too. Resource development actually depends upon the combination of nature, man and culture. But these basic factors and the pattern of their combination vary from one region to another. And therefore, as between region and or between country and country, there are differences in pattern of resource development and utilization activities- in agriculture, manufacturing, mining, fishing, forestry and also in transport and trade.

MAN AND CULTURE: Among these basic factors again, nature remains more or less fixed, but the two factors, namely man and culture are ever changing. Therefore, the combination or inter-action of these resource factors, i.e., nature, man and culture, in a particular region may differ from time to time. This leads to a change in the

pattern of resources and resource development activities. Thus one has to explore into resource and resource factors for proper understanding of human economic activities of a region.

Therefore, a reasonable study of economic Geography implies a critical enquiry into natural, human, and culture resources, as they are in different parts of the world- their regional combination and resultant effects in the form of resource- building and utilization activities.

Such an approach to the subject leads one into a region- wise comparative study; because under similar condition activities should tend to be similar. A comparative study reveals the stages of development of the resource factors in a region,- whether they are fully developed or under-developed. It also gives indications of future tendencies, prospects and possibilities of a region.

■ 8.1.6 CULTURAL DEVELOPMENT AND RESOURCE

Culture includes all man - made things which have some positive effects on the development of resources. It is a joint product of man and nature. Knowledge, human skill, tools, machine, transportation, social institutions are examples of culture. Many of the culture items are resources, at the same time they help the creation of further resources. Thus culture is a resource creating factor. In fact, the rate of resource creation in a society depends on the extent of its culture. But however high the human culture may be its function rests on the physical base, i.e., nature. It is helpless in a vacuum.

Thus, in resource creating both for man and culture, there must be a physical background. And this physical background is provided by nature. And interaction of nature, man, and culture creates resources and makes each of them functional. In other words nature, man and culture are the three resource creating factors. But one should not miss the point that 'human want' is the motive force behind the creation of resources. So, the interaction must be purposeful, i.e., for satisfying human wants.

■ 8.1.3 ECONOMIC CONCEPT OF RESOURCE AND COMPARED WITH WEALTH

There are many points of similarity between wealth and resource. In economics, any thing which possesses value-in-exchange is wealth. It may be a material as well as non-material thing. It has three essential attributes:

(i) It has utility.

(ii) It has scarcity or limitation in supply.

(iii) It has transferability or marketability.

Land, buildings, machinery, mortgage rights, stock and shares are all wealth. But sunshine, sand, air, water are not wealth, for they are not scarce. Again, education, social institutions, good government, knowledge, etc. are not wealth, for they are not transferable or marketable.

In the words of J. M. Keynes "Wealth consists of all potentially exchangeable means of satisfying human

needs". So wealth is related to man. It refers to benefits arising from its use. To an illiterate a book of Kalidas' drama is not wealth. Therefore, like resources, wealth also has the functional aspect.

Resource covers a wider field than wealth. All material and non-material means of satisfying human and social needs are resources. It has only two essential attributes, that is:

(i) Utility.

(ii) Functionability.

Land, building, machinery, mortgage rights, shares and stocks are resources. At the same time, sunshine, sand, air, mountains, rivers, water, education, useful social institutions, a good government, public health, knowledge, a flawless national character and culture are all resources. They fulfill both the attributes of the resources. They have utility and they function for satisfying human and social needs.

Scarcity and marketability or value-in-exchange is not essential attributes for resources as they are for wealth. In defining wealth the economist gives particular emphasis on scarcity and value-in-exchange. But for resources these two characteristics are not necessarily essential. Here the emphasis is on their functional aspect, i.e., the benefits arising from their use. It does not matter whether they have value-in-exchange or not.

Anything which possesses value-in-exchange is wealth. Whereas anything which possesses the capacity to function as means for satisfying human needs at a given time and place is resource.

As stated in the definition given earlier, resource satisfies human wants and brings human welfare. That is to say, resource is something functional to man. The term 'functional' denotes function able character, i.e., the capacity of satisfying human wants.

A natural phenomenon which can satisfy human wants is functional and so a resource. The sunshine which helps our organic growth, the air which we breathe, the solid earth on which we stand, are automatically resources. They are functional in their original state and forms. But most of the natural things, e.g., minerals, soils rivers, water-falls, forests, etc. did not processes their functional capacity in their original state. As long as coal was unknown to man and was lying underground, it had all its inherent qualities but it was not functional to man. It was then a 'natural stuff" and not a resource. It acquired its functional capacity when man by his efforts discovered it and learn the art of putting it into various uses. To-day coal is a tremendous resource.

Without functional capacity coal was a natural stuff; with functional capacity coal is a resource. Therefore, resource is nothing but the functional capacity of a thing which satisfies human wants and brings welfare. The functional character or function ability of resource is of paramount importance. Even for non- material resources, it is an essential characteristic. Importance of function ability can be seen in following examples:-

To repeat the example of coal, it may be pointed out that the matter in coal is natural but its functional capacity has been conferred on it by man. In the same manner, man has conferred functional capacity on host of natural

things, e.g., rivers, water-falls minerals, forests soils, etc. and turned them into resources. Thus resources are made. They are not already in nature

■ 8.1.8 RESOURCE CREATING FACTORS

Three components of resource development are nature, man and culture. No resource can be created in the absence of these three components. Nature provides all the materials which are converted by man into resources with the help of culture.

1. *NATURE:*

Nature acts as a resource creating factor in two ways: by providing all the materials and by providing the environment for the creation of resource.

● SOURCES OF MATERIALS:

Role of nature as ' store house' may be identified as follows:

[i] Survival of man is dependent on nature; for example, oxygen for breathing, drinking water, food, etc.

[ii] Sources of all energy inputs are found in the nature.

[iii] All the raw materials for resource development are supplied by nature.

[iv] Uneven distribution pattern of natural endowments causes the variation economic development.

[v] Man learns to depend on those natural endowments which are available to him. So, need is conditioned by the availability.

● NATURAL ENVIRONMENT FOR RESOURCE CREATION

Natural sets the outer limit for resource development. Natural environment has two components- biotic environment and a biotic environment. A biotic environment is also known as physical environment which includes climate, soil and land form. Physical environment plays a very important role in the processes of resource development.

2. *MAN*

Resource is created for the man and by the man. In other words, man is the producer and consumer of all resources, thereby performing a dual role

● MAN AS A PRODUCER

As producer, man takes part in the resource development at two levels. At animal level man uses his physical energy to produce goods and services. So, it is the use of animate energy in the production system.

At human level knowledge, skill creative abilities, talents and attitudes form the productive power of man. These are in addition to the physical ability of man. At human level man uses his analytical power to transform natural substances into resources. At this level, man is better prepared to overcome resistances and also to convert some of these resistances into resources.

- **MAN AS A CONSUMER**

Man is a resource creating factor not only as a producer but also as a consumer. Some thing is defined as resource when it satisfies the demand of man. All the goods and services which are produced by man are used to satisfy his own demand

3. *CULTURE*

The word 'culture' is defined as the quality in a person or society which arises out of knowledge, experience, education and perception. Culture is considered as a derived factor because it results from the interaction between nature and man. It is also regarded as the analytical power of mind which man utilities at 'human level'. Culture is divided into two categories- material culture and non- material culture.

- **MATERIAL CULTURE:**

Material culture includes economic practices. Cultures of man adds function ability to the materials and make them resource. For example, use of coal as a source of power is the conversion of neutral substance into resource.

- **NON-MATERIAL CULTURE:**

Non- material culture includes literacy, social customs, social practices, etc. Perception ideology, skill and organization are the products of non-material culture which influence the resource development processes.

■ 8.1.9 CLASSIFICATION OF RESOURCE

WHY RESOURCES NEED TO BE CLASSIFIED: Recent research has shown that abundant natural resources raise the risk of conflict onset and may prolong conflict duration. It is, however, not sufficient to simply state that natural resources cause and fuel conflicts as this leaves little hope for resolving current conflicts and possibly preventing others. It is essential to study why, how and to what extent natural resources affect conflict propensity and duration.

To achieve this goal, it is important to recognize that not all resources share the same characteristics. For example, wheat production differs considerably from the extraction of precious gemstones even though both would be classified as primary products in export statistics. Similarly, minerals differ from each other and a relevant difference between mineral resources might be the ease of exploitation. Some resources require relatively minimal investment on extraction equipment and they can be exploited under conflict conditions by a small band of people or by individuals (for example, extraction of placer gemstones in Sierra Leone and Myanmar to finance rebel

movements). Other resources may require extensive investment in production technology and a stable investment environment to encourage the necessary investment and expertise from large multinational companies. Resources in the second category are better extracted during peaceful conditions, even though the presence of valuable resource may motivate fighting over the control of resource and the associated revenues (for example oil in Aceh, Indonesia, in Cabina, Angola and in Southern Sudan).

On the basis of biogenesis, resources may be divided into:

- **Biotic** - Biotic resources are the ones which are obtained from the biosphere. Forests and their products, animals, birds and their products, fish and other marine organisms are important examples. Minerals such as coal and petroleum are also included in this category because they were formed from decayed organic matter.
- **Abiotic** - Abiotic resources comprise of non-living things. Examples include land, water, air and minerals such as gold, iron, copper, silver etc.

On the basis of renewability, natural resources can be categorized into:

- **Renewable Resources** - Renewable resources are the ones which can be replenished or reproduced easily. Some of them, like sunlight, air, wind, etc., are continuously available and their quantity is not affected by human consumption. Many renewable resources can be depleted by human use, but may also be replenished, thus maintaining a flow. Some of these, like agricultural crops, take a short time for renewal; others, like water, take a comparatively longer time, while still others, like forests, take even longer.

  Solar power is the energy derived directly from the Sun. It is the most abundant source of energy on Earth. It is captured by photovoltaic cells, or by using sunlight to heat water. The Sun will continue to shine for about 5 billion years.

  Wind power is derived from uneven heating of the Earth's surface from the Sun and the warm core. Most modern wind power is generated in the form of electricity by converting the rotation of turbine blades into electrical current by means of an electrical generator. In windmills (a much older technology) wind energy is used to turn mechanical machinery to do physical work, like crushing grain or pumping water.

  Hydropower, energy derived from the movement of water in rivers and oceans (or other energy differentials), can likewise be used to generate electricity using turbines, or can be used mechanically to do useful work. It is a very common resource.

  Geothermal power directly harnesses the natural flow of heat from the ground. The available energy from natural decay of radioactive elements in the earth's crust and mantle is approximately equal to that

of incoming solar energy.

Alcohol derived from corn, sugar cane etc. is also a renewable source of energy. Similarly, oils from plants and seeds can be used as a substitute for non-renewable diesel. Methane is also considered as a renewable source of energy.

- **Non-renewable Resources** - Non-renewable resources are formed over very long geological periods. Minerals and fossils are included in this category. Since their rate of formation is extremely slow, they cannot be replenished once they get depleted. Out of these, the metallic minerals can be re-used by recycling them. But coal and petroleum cannot be recycled. At present, the main energy sources used by humans are non-renewable.

On the basis of availability, resources can be classified into:

a) Type of availability

- **Physical availability** is the quantitative measurement of resource. For example, total quantity of coal which is available from a coal mine is the physical availability of this resource. Physical availability increases with new discoveries and decreases with its uses.
- **Functional availability** is the qualitative measurement which means the functional value of resource. For example, functional availability of petroleum means its fuel and non-fuel use. In addition to fuel, petroleum may be used as raw material for chemical industries.

b) Nature of availability

- **Flow resource** is a type of resource which is continuous and availability remains unchanged irrespective of the rate of utilization. This type of resource is self-renewable, inexhaustible and totally time independent. For example, sea water, sunlight, tidal waves etc.
- **Fund resource** is an exhaustible or non everlasting type which destroyed for ever after use. For example, petroleum, coal, uranium etc.

On the basis of distribution, resources may be divided into:

- **Ubiquitous** type of resources are available everywhere and generally not influenced by local decision, e.g., sunshine, air etc.
- **Localized** or rarities of resources are available only in some places, e.g., uranium, petroleum, coal, iron ore, gold etc. and these are also considered as scarce resource.
- **Common** resources are common in most of the places but not available in everywhere. For example, water, soil etc.

- **Unique** resources are found in only one place of the country or in the world, e.g., uranium mining of Jadugora in India.

On the basis of the stage of development, natural resources may be called:

- **Potential Resources** - Potential resources are those which exist in a region and may be used in the future. For example, mineral oil may exist in many parts of India having sedimentary rocks but till the time it is actually drilled out and put into use, it remains a potential resource.
- **Actual Resources** are those which have been surveyed, their quantity and quality determined and are being used in present times. For example, the petroleum and the natural gas which is obtained from the Bombay High Fields. The development of an actual resource, such as wood processing depends upon the technology available and the cost involved. That part of the actual resource which can be developed profitably with available technology is called a reserve.

On the basis of ownership, resources can be classified into:

National, international, community, and individual resources

On the basis of human beings, resources can be classified into:

- **Human resources:** Human beings are also considered to be resources because they have the ability to change raw materials into valuable resources. The term Human resources can also be defined as the skills, energies, talents, abilities and knowledge that are used for the production of goods or the rendering of services. While taking into account human beings as resources, the following things have to be kept in mind:

  i) The size of the population

  ii) The capabilities of the individuals in that population

- **Human-made resource:** Human-made resources are those aids of production which have been created by humans to transform and utilize the gifts of nature as well as improve or increase productivity. These include:

  Equipment, machinery, buildings etc. - These are essential for the production of commodities. They are also referred to as the physical capital of production.

  Technology - Technology refers to the process or method by which goods are produced. Rapid industrialization in many parts of the world has been possible due to the advancement in technology.

  Legal bodies and political, cultural and social institutions - Legal bodies and political institutions maintain law and order thus ensuring that people are free to move about and carry their business. The

policies of the government concerning international trade and foreign investment also influence productivity.

Entrepreneurship - Innovation, vision, creativity, and risk. This is by far the most abstract.

■ 8.1.10 RESOURCE MANAGEMENT

In organizational studies, resource management is the efficient and effective deployment of an organization's resources when they are needed. Such resources may include financial resources, inventory, human skills, production resources, or information technology (IT). In the realm of project management, processes, techniques and philosophies as to the best approach for allocating resources have been developed. Resource management is a key element to activity resource estimating and project human resource management. Both are essential components of a comprehensive project management plan to execute and monitor a project successfully. As is the case with the larger discipline of project management, there are resource management software tools available that automate and assist the process of resource allocation to projects and portfolio resource visibility including supply and demand of resources.

■ 8.1.11 NATURAL RESOURCE MANAGEMENT

Natural resource management is a discipline in the management of natural resources such as land, water, soil, plants and animals, with a particular focus on how management affects the quality of life for both present and future generations. The discipline has given rise to the notion of sustainable development, a principle which forms the basis for land management and environmental governance throughout the world.

■ 8.1.12 MECHANICAL MEASURES

The main occupation of the hill farmers is agriculture. They usually construct terraces for cultivation known as *nala* with risers known as *pusata*. These terraces are small but there are many of them. In one acre of landholding a farmer possesses 50 *nala*s. In these it is possible to manage to rainwater. Construction of terraces depends upon space and grades of land. The farmers, with their expertise, are able to prepare fields for crop production.

- According to scientific recommendations cultivation is allowed to 33 per cent of land slope. But in the hills, farmers are able to make terraces from top to bottom of the mountain terrain without taking into account the land slope. With terraces they construct loose boulder retention walls (risers) by putting grass over them. These grasses keep both stones and the land intact.
- Cement and sand are scarce materials in the hills. In making risers farmers simply arrange boulders of the proper size along the terrace wall. It retains the soil perfectly and gradually gets stabilized.
- Farmers make the slopes of the terraces inwards to check soil erosion and enhance *in situ* moisture conservation. Soils are gravelly and have a high rate of percolation. Due to rainwater retention enough moisture becomes available to the crops.

- On mild slopes farmers construct shoulder bunds to protect their lands from soil erosion and grow vegetation over the bunds, particularly grasses for binding the soil.
- Farmers of the hill region used to make brushwood or long wood check dams across the drainage channels for controlling soil loss by means of local materials. They are economical. Gabion walls and stone check dams are by and large cost intensive and beyond not affordable to hill farmers.

■ 8.1.13TRADITIONAL KNOWLEDGE FOR NATURAL RESOURCE MANAGEMENT

- In order to achieve the objective of development in villages, people's participation is essential. It is required to involve them actively in project activities by respecting their traditional knowledge and experimental ethics. Traditional knowledge has a sound base as it has been tested and practiced over the years. It is appropriate technology in particular climatic conditions and in the living conditions of people.
- Projects to develop ecology should start with traditional knowledge as they are proven technology for natural resources management. In a real sense, every culture of a social system, traditionally, is the result of people's action to survive and their attempts to optimise the use of available resources, i.e., soil, water and vegetation.
- The science of natural resource management is based on the ecologically sound traditional wisdom of farmers and its contribution in augmenting productivity. Traditional values which are sustainable in nature need to be compared with values of modern systems. It is obvious that traditional practices of agriculture may disappear unless their values are promoted.
- The wisdom of farmers with respect to watershed development, agricultural management, and conservation of soil, water for sustained production are documented in the present investigation.

Human Resource Management

This is the science of allocating human resources among various projects or business units, maximizing the utilization of available personnel resources to achieve business goals; and performing the activities that are necessary in the maintenance of that workforce through identification of staffing requirements, planning and oversight of payr[illegible] and benefits, education and professional development, and administering their work-life needs. The efficient and effective deployment of an organization's personnel resources where and when they are needed, and in possession of the tools, training and skills required by the work.

Techniques

- One resource management technique is resource leveling. It aims at smoothing the stock of resources on hand, reducing both excess inventories and shortages.
- The required data are the demands for various resources, forecasted by time period into the future as

far as is reasonable, as well as the resources' configurations required in those demands, and the supply of the resources, again forecasted by time period into the future as far as is reasonable.

- The goal is to achieve 100% utilization but that is very unlikely, when weighted by important metrics and subject to constraints, for example: meeting a minimum service level, but otherwise minimizing cost.
- The principle is to invest in resources as stored capabilities, and then unleash the capabilities as demanded.
- A dimension of resource development is included in resource management by which investment in resources can be retained by a smaller additional investment to develop a new capability that is demanded, at a lower investment than disposing of the current resource and replacing it with another that has the demanded capability.
- In conservation, resource management is a set of practices pertaining to maintaining natural systems integrity. Examples of this form of management are air resource management, soil conservation, forestry, wildlife management and water resource management. The broad term for this type of resource management is natural resource management (NRM).

Use of alternate resources

Biomass energy: Changing farming wastes, grasses, trees, bark, sawdust, and other things into energy by burning it, changing it to a gas, or converting it to a liquid fuel.

Energy crops: Crops grown specifically for their fuel value, including food crops such as corn and sugarcane, and nonfood crops such as poplar trees and switchgrass.

Fossil fuels: Energy sources formed by the decay of plants, dinosaurs, and other animals over millions of years; coal, oil, and natural gas are fossil fuels.

Geothermal energy: Using the heat from the earth to produce power.

Hydropower: Using the energy in flowing water to make electricity.

Municipal solid waste: Using trash or garbage to produce energy by burning it or by capturing the gasses it gives off and using them as fuel.

Nonrenewable fuels: Fuels that cannot be easily made or "renewed." We can use up non-renewable fuels. Oil, natural gas, and coal are nonrenewable fuels.

Passive solar heater: A solar water-heating or space-heating system that moves heated air or water without using pumps or fans.

Passive solar home: A house that uses a room or another part of the building as a solar collector.

Photovoltaic energy: A type of solar energy that converts sunshine into electricity.

Renewable energy: Types of energy that are "renewed" as we use them; solar, wind, and geothermal energy are forms of renewable energy.

Solar collectors: Boxes, frames, or rooms that trap the sun's rays to produce heat.

Solar energy: Energy from the sun. The heat that builds up in your car when it is parked in the sun is an example of solar energy.

Solar heating: Using the sun's energy to heat our homes and water.

Wind power: Using the wind to produce electricity by turning blades on a wind turbine.

Wind power plant: A group of wind turbines interconnected to a common utility system.

■ 8.1.14 CONCEPT OF SUSTAINABILITY

'Sustainability', in a general sense, is the capacity to maintain a certain process or state indefinitely. In recent years the concept has been applied more specifically to living organisms and systems. As applied to the human community, sustainability has been expressed as meeting the needs of the present without compromising the ability of future generations to meet their own needs.

The term has its roots in ecology as the ability of an ecosystem to maintain ecological processes, functions, biodiversity and productivity into the future.[2] To be sustainable, nature's resources must only be used at a rate at which they can be replenished naturally. There is now clear scientific evidence, (environmental science), that humanity is living in an unsustainable way, by consuming the Earth's limited natural resources more rapidly than they are being replaced by nature. Consequently, a collective human effort to keep human use of natural resources within the sustainable development aspect of the Earth's finite resource limits is now an issue of utmost importance to the present and future of humanity.

■ 8.1.15 DEFINITION OF SUSTAINABILITY

Forum for the Future: Sustainable development is a process which enables all people to realize their potential and improve their quality of life in ways which protect and enhance the Earth's life support systems.

Alliance for Global Sustainability: Sustainability can be described as a system (e.g., ecosystem) within which various parts/elements interact. A better understanding/characterization of this system is needed to make integrated decisions that affect the environment, such as product design.

Brundtland (1987): This is the most commonly quoted definition and it aims to be more comprehensive than most:

Sustainable development is development that meets the needs of the present without compromising the needs

of future generations to meet their own needs.

It contains within it two key concepts:

i) The concepts of needs, in particular the essential needs of the worlds poor, to which overriding priority should be given, and:

ii) The idea of limitations imposed by the state of technology and social organization on the environments ability to meet present and future needs.

■ 8.1.16 MEASURES OF SUSTAINABILITY

Sustainability is related to the quality of life in a community — whether the economic, social and environmental systems that make up the community are providing a healthy, productive, meaningful life for all community residents, present and future. How has the quality of life in your community changed over the last 20 or 40 years?

- How has your community changed economically?
  - Are there fewer or more good-paying jobs — are people working more and earning less or are most people living well?
  - Is there more or less poverty and homelessness?
  - Is it easier or harder for people to find homes that they can afford?
- How has your community changed socially?
  - Is there less or more crime?
  - Are people less or more willing to volunteer?
  - Are fewer or more people running for public office or working on community boards?
- How has your community changed environmentally?
  - Has air quality in the urban areas gotten better or worse?
  - Are there more or fewer warnings about eating fish caught in local streams?
  - Has the water quality gotten better or worse?

Economic sustainability

Economic sustainability is not just about achieving economic growth year on year. It's about understanding that economic growth is only sustainable if it simultaneously improves our quality of life and the environment. Economic Sustainability focuses on the importance of stable economic growth. The goal of community sustainability is to establish local economies that are economically viable, environmentally sound and socially responsible. Achieving

this goal requires participation from all sectors of the community, both to determine community needs and to identify and implement innovative and appropriate solutions. This section presents information from a variety of sources on approaches and techniques used successfully in different communities to develop key aspects of their local economies on a sustainable basis.

Environmental Sustainability

Environmental sustainability is the ability to maintain the qualities that are valued in the physical environment. For example, most people want to sustain (maintain):

- human life
- the capabilities that the natural environment has to maintain the living conditions for people and other species (e.g. clean water and air, a suitable climate)
- the aspects of the environment that produce renewable resources such as water, timber, fish, solar energy.
- the functioning of society, despite non-renewable resource depletion.
- the quality of life for all people, the livability and beauty of the environment.

Threats to these aspects of the environment mean that there is a risk that these things will not be maintained. For example, the large-scale extraction of non-renewable resources (such as minerals, coal and oil) or damage done to the natural environment can create threats of serious decline in quality or destruction or extinction.

Traditionally, when environmental problems arise environmental managers work out how to reduce the damage or wastage. But it is not always easy to work out exactly when and where threats will have their effects and often the impacts are hard to reverse. So increasingly environmental managers adopt strategies aimed to prevent damage being done in the first place. A full sustainability program needs to include actions to prevent threats and impacts from arising, actions to protect the environment from threats and damage, and restoration to reverse damage already done.

Sustainability issues arise wherever there is a risk of difficult or irreversible loss of the things or qualities of the environment that people value. And whenever there are such risks there is a degree of urgency to take action.

Environmental sustainability programs include actions to reduce the use of physical resources, the adoption of a 'recycle everything/buy recycled' approach, the use of renewable rather than depletable resources, the redesign of production processes and products to eliminate the production of toxic materials, and the protection and restoration of natural habitats and environments valued for their livability or beauty.

Social sustainability

Social sustainability is focused on the development of programs and processes that promote social interaction

and cultural enrichment. It emphasizes protecting the vulnerable, respecting social diversity and ensuring that we all put priority on social capital. Social sustainability is related to how we make choices that affect other humans in our "global community" — the Earth. It covers the broadest aspects of business operations and the effect that they have on employees, suppliers, investors, local and global communities and customers. Social sustainability is also related to more basic needs of happiness, safety, freedom, dignity and affection. As a society, we make social investments and we have a "stock" of social and human resources. Economic development can either contribute to or deplete those social resources (Osberg, 1990). Many would argue that the form of economic development championed by Thatcher and Reagan has been socially unsustainable, depleting human and social capital and resources in addition to the damage it has wrought to the natural environment. The concept of socially sustainable development including socially sustainable urban development 1992) has received less attention than the concept of environmentally sustainable development. What would constitute socially sustainable development? One would argue that it is development that it :

- meets basic needs for food, shelter, education, work, income and safe living and working conditions;
- is equitable, ensuring that the benefits of development are distributed fairly across society;
- enhances, or at least does not impair, the physical, mental and social well-being of the population;
- promotes education, creativity and the development of human potential for the whole population;
- preserves our cultural and biological heritage, thus strengthening our sense of connectedness to our history and environment;
- promotes conviviality, with people living together harmoniously and in mutual support of each other;
- is democratic, promoting citizen participation and involvement, and
- is livable, linking "the form of the city's public places and city dwellers' social, emotional and physical well-being" (Lennard and Lennard, 1987)

■ 8.1.17 SELF ASSESMENT QUESTIONS

1. What is resource? "Resource is a dynamic concept". Explain
2. Define resource. Discuss about the modern trend in resource development.
3. Define resource. Classify resources and give suitable examples.
4. "Resource does not refer to a thing or substance but to a function which a thing or substance may perform"- Justify the statement and state how culture and human wants augment the functionality of resources.
5. Analyze the functional theory of resources and indicate the modern trends in resource development.
6. "Resource is a dynamic concept"-Elucidate.
7. What are the resource creating factors? Briefly sate how they function in resource creation.
8. Explain fully how resources evolve out of the dynamic interaction of natural, human and cultural forces. Illustrate your answer by suitable examples
9. Why resource functions differ from place to place and from time to time? Explain with examples.
10. Define resource. Justify the statement. The concept of resource is dynamic.

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M.A. / M. Sc. Part - I
Paper - IV : Module - VIII
Unit - 03

RESOURCES USE AND MANAGEMENT

Module Structure

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- 4.8.3.4. Agricultural Resources : Role to Meet the Nutritional Requirements of the World Population, Supply Raw Materials for the Industries, Alternative Conservation and Alternative Methods of Production
  - 4.8.3.4.1. Role to Meet the Nutritional Requirements of the World Population
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Paper: IV Module: VIII

Unit - 03

Structure of the Unit

- Use and Misuse of Forest Resource
- Concept of Social Forestry and Joint Forest Management
- Agricultural Resources : Role to Meet the Nutritional Requirements of the World Population, Supply Raw Materials for the Industries, Alternative Conservation and Alternative Methods of Production

■ 4.8.3.0. INTRODUCTION :

Resource; an important subject matter in Geographical study, is associated with man's productivity. It becomes a clutch to the socio-economic development of a region. With the improvement of knowledge about the nature and advancement of science accordingly, people discovered many resources and the multipurpose-uses of a single resource. With the increasing population and industrialisation uses of different resources have been increased among the people. The most important feature of natural resources is that they are unevenly distributed on the surface of the earth. Natural resources expand with proper use and get contracted by misuse. Forest resources are significant to the people for their life and livelihood, and also for the global environment. Agricultural resources also get noteworthy importance throughout the world with the increasing population, and there is increasing demand of food and agro-based industries. In this context the concept of *resource management* cannot be ignored insofar as environment protection and economic development of a region is concerned. Resources are to be used wisely with technical supports to meet the needs of the present generation and conservation of them is also important for the future generation.

■ 4.8.3.1. OBJECTIVES :

Presents objectives are:

- to study importance, uses and misuses of forest resources;
- to describe the concept of social forestry and joint forest management;
- to explain the role of agricultural resources as food for the world population and as raw materials of the agro-based industries; and
- to evaluate the concept of alternative agriculture and alternative methods of agricultural production.

■ 4.8.3.2. USE AND MISUSE OF FOREST RESOURCE :

Forest, a complex ecosystem, covering an extensive area, consisting mainly of trees, buffers the earth and supports a myriad of life forms directly and indirectly. Forestry is the art and science of managing forests, tree plantations, and related natural resources. The extent of forests and natural resources of great importance have declined with time. It is due to multi-purpose uses of them and is a consequence of other factors too. Trees are

cleared recklessly and are subjected to be auctioned off. Forest resources are products of living systems. They are renewable by nature and significant in providing their biological capital. This capital refers to overall variety and variability of the goods and services as well.

In general forests are sub-divided into natural forests and plantations. Natural forests consist mainly of indigenous trees not deliberately planted, whereas, plantations by being planted seedlings or seeds as the case may be by conscious human efforts in the process of afforestation or reforestation. Broadly based on spatial distribution of the forests throughout the world there are four major divisions. These are: 1) equatorial evergreen hardwood rain forest; 2) tropical deciduous hardwood forest; 3) temperate deciduous hardwood forest; and 4) coniferous softwood forest.

● 4.8.3.2.1. Importance

Forest is referred to as a biome dominated by trees. Green plants can consume carbondi-oxide (COZ) and exclude oxygen (OZ) in the period of their photosyflthesis. Thus they play a dominant role to save faunas inhabiting our environment. Forests have physical, pedological, climatic, economic, social, floral and faunal significances. They influence agriculture; grazing, recreation and wildlife. Forests provide energy as fuel-wood, industrial-wood products, food, fodder, medicinal products, and other non-wood products such as fibres, rubbers; gums and resins. Forests are also considered as ecological resources protecting land and water resources, controlling floods and droughts, checking wind erosion, storing and cycling nutrients, and providing habitats for the wildlife inhabitants. They constitute a rich stock of valuable genetic resources --- a common heritage of mankind.

Sir John Boyd Orr estimated that over 40% of the lands of the earth, excluding the Polar Regions, were originally covered by forests. But at present nearly 34% of the original forest coverage has been destroyed by man for the very purpose of his use of forests. It can be said tlqt moW or less two-thirds of the total forest area are productive. And, nearly 30% of all forests are in use today as well.

●4.8.3.2.2. Uses

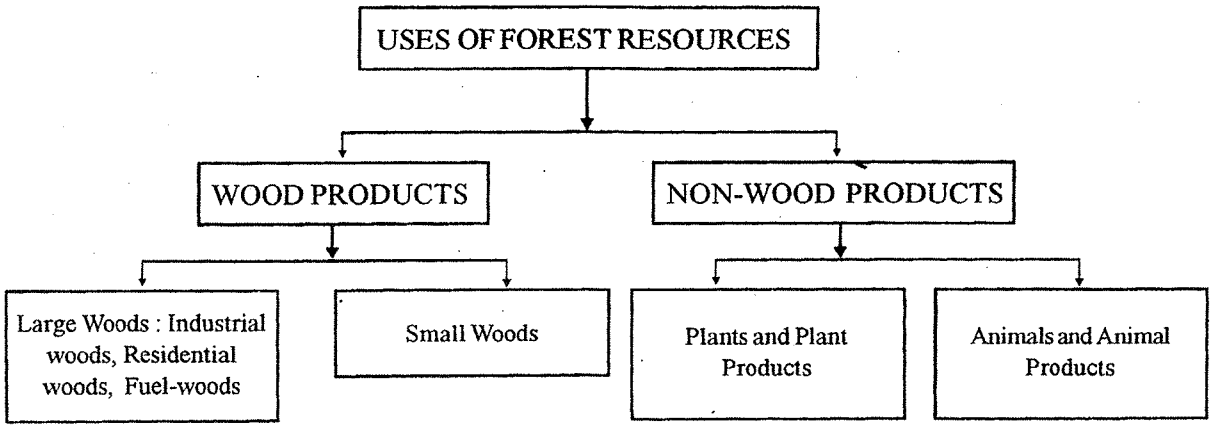

Figure : 1

When we analyse uses of the forest resources then there are some important terms should be kept in mind. These are *by-products of forests, minor forest products, non-timber forest products, non-wood goods and benefits, non-wood goods and services, other forest products, secondary forest products, and special forest products.* Figure 1 shows there are two types of forest products based on their use. The term product refers to the goods that are sensible and physical objects of biological origin such as plants, animals, and their products. But, it does not refer to forest services like ecotourism, grazing, and forest benefits --- soil conservation, soil fertility etc. Wood Forest Product (WFP) consists mainly of timbers, chips, charcoal, fuel-woods, and small woods for the purposes of tools, household equipments and carvings. Non-Wood Forest Product (N1N'FP) consists of goods of biological origin other than woods and services. Non-Timber Forest Product (NTFP) generally includes fuel-woods and small woods. This is the main difference between NWFPs and NTFPs. NWFPs are obtained from forests. Now plantations are included in the FAO definition of forest. Therefore, which are collected from plantations, such as rubber, are included in the definition of NWFPs. Many NWFPs. are thus obtained from both natural forests and plantations. Now we are going to discuss the uses of,the natural forest resources. Generally people depend on forests for paper, timber, fuel-wood, medicine and fodder.

Fuel-wood is the most important source of domestic energy for the purpose of cooking and heating in the rural areas of many developing oomorm Ay srif of the world's population cook by using biomass fuels, which provide abaw 39%4/40wv supplies in the developing countries (World Bank, 1992). Some of the woods is converted to charcoal and used for cooking. *Fodder* is significant to the cattle and other grazing animals in the hilly areas and in the arid regions, particularly during a drought. There are different kinds of grasses, trees and shrubs which are nutritious for the livestock- be drunimpft countries *fencing* is used to protect something. It is created by the trees and shrubs. Species should be fast growing, hardy, and long lived. Trees in the forests are also used as *wind breaks* and *shelter belts.* Along the coast of Digha in West Bengal, jhau has succiesdift &s planted to check sand degradation due to coastal winds. Trees are used to check ad ara Tree roots bind the soil and prevent erosion caused by wind or water. Leaf fall aim prwuis a soil cover that further protects the soil.

• 4.8.3.2.2.1. World

Equatorial evergreen hardwood rain forests are found within the areas of 5^{0} N and 5^{0} S on both sides of the equator. There have many valuable trees like mahogany, ebony. palm, rosewood, cedar, rubber etc. In the equatorial forests climate is generally apppsed to enter into the deep-core area. Therefore, only 10% of the world's total collected ooibei comes from this forest. Besides timer, significant resources are nuts, resins, balata, rubber, palm oil etc.

Tropical deciduous hardwood forests with monsoon type of climate are found in different countries of the world: About 80% area of the total broad-leaved deciduous forests is estimated in the tropical zone and remaining 20% is found in the temperate zone. Significant chief resources are bamboo, palm, rubber, mahogany. sal, teak, ebony, sandalwood, jarul, sishu etc. From these forests lac, gum, sandalwood, spices, camphor, cinchona, myrobalan and indigo are collected as important forest products.

In the equatorial and the tropical forests different gathering and extraction industries are found to establish. *Spices:* Important available spices are pepper, cloves, cinnamon and vanilla. *Chicle:* To manufacture chewing gum it is prepared from the milky juice gathered from zapote trees. *Nuts:* The ivory nuts are used in the manufacture of buttons. In India there are betel nuts and coconuts for the industrial purposes. *Palm products:* These are used in the manufacture of soap, glycerine, margarine etc. *Drugs:* Quinine is obtained from the barks of cinchona trees and

camphor is obtained by distillation from the wood over boiling water. Besides, different medicinal substances are gathered from the tropical forests. Wild *rubber:* Wild rubber is extracted for the manufacturing industries. There many species of lumber are found as hard and heavy. Lumbering supplies wood in the form of logs, planks, etc. Mahogany for cabinet work is greatly demanded. Cedar is used for making pencils, cigar boxes, chests, and for general purposes. Teak has high demand throughout the world due to its strength and durability. It is used in ships as a preservative for it contains oil. It is characterised by resistant to white ants and to fire.

Temperate deciduous hardwood forests are situated in the areas of moderate temperature and rainfall. Important tree resources are oak, birch, beech, ash, chestnut, maple, walnut etc. Corks are obtained from the barks of oak trees. Other forest products like nuts, olive oil and various fruits are also collected from these forests, especially from Mediterranean forests. The hardwood timbers are used for furniture making, constructing masts of ships, and house building purposes. Walnut wood is used for making bats and rackets. Based on temperate forests, there is found to set up different gathering and extraction industries. But, the temperate forests supply fewer forest materials than the tropical forests. *Tannin:* There is extraction industries of tannin from the chips of chopped up quebracho trees in Argentina and Paraguay. Cork: It has great demand for the bottle stoppers, insulating refrigerators, as linings for hats and shoes, as washers, bicycle handles etc. Oil *extraction: It* is important as extraction of eucalyptus and olive oil. *Naval stores:* From the pine forests tar, pitch and turpentine are extracted. Turpentine is used for paints and varnishes. Resin is used for manufacturing soaps, paper coverings, chemicals and paints. Temperate forests supply maximum amount of the world's timber and wood-pulp. Therefore lumbering industry is observed to establish very much in these areas from the commercial point of view. Pacific coast of North America is the leading source of supply of timber of douglas fir. Pine is the most important species of lumbering in the Southern U.S.A. Paper, rayon and plastic industries are found to develop based on pine lumbering. Important pulp and paper industries are found to set up based on these fore6is in Canada, Alaska and Central Europe.

Coniferous softwood forests are found in the areas between 50^0 N and 70^0 N. More than 50% of the world's wood supply and 67% of the timber cut for lumbering come from these forests. Important tree resources are pine, fir, larch and spruce. These are used for timber, paper making, and to manufacture cellulose. At present of the world's total demand of industrial timber per year these forests yield about 37 %. Based on coniferous forests lumbering industry has been developed very well. From these areas timber, wood pulp, paper and matches are exported. Norway, Sweden, Finland etc are very famous for lumbering. East Central North America and Europe manufacture about 90% of the wood pulp and paper of the world.

▲ 4.8.3.2.2.2. India

Indian forests contain more than 5000 species of wood producing trees. Of which about 450 are commercially important. There annually more than 56.87 crores cubic feet of wood are collected. It is estimated that around 70% woods of the soft wood yield are used in the industrial sectors and remaining 30% is burnt. But considering the hard wood, around 70% wood is burnt and less than 30% goes for industrial uses. Important timber resources include teak, ebony, greenheart, rosewood, mahogany, deodar, sal, padauk, nahar, poon, toon, chaplash, bishop, sirish, sisoo, gurjan, sundari, haldu etc. The demand of timbers is being increased with the growing industrialisation. In timber-based industries trees are generally used for plywood, saw-milling, paper and pulp, and particle boards. Based on gathered and extracted forest products, important industries are lumbering, furniture making, paper manufacturing, tea-chest making, match box making, lac worm rearing and lac collection, charcoal making, extraction of oil such as sandal oil, mohua oil, turpentine oil, resin, gums etc. Bamboos are commercially worked as timber

substitutes, fodder, and raw material for basket, paper and pulp, and other small-scale industries. Canes or rattans are used for a large number of household items, such as walking sticks, baskets, picture frames and mats. There are several varieties of grasses that are used for a number of purposes. Wild fruit trees of the forests are an important source of income and food for the rural people. Different forested medicinal herbs and plants are collected to obtain medicines. Of all the medicinal trees, the neem is the most important in India. Some medicinal herbs like atropa, belladona, nux vomica, aconite, hyoscyamus etc are collected from the forests. Leaves, barks, and other parts are used to prepare various ayurvedic medicines. Plant fibres have many different uses. There are soft fibres such as jute and hard ubres from the leaves of sisal and hemp used to make fabrics for several uses. Coir is another form of fibre of the fruit of the coconut significant to make ropes. In India different kinds of fruits of different trees produce silky floss. Of these simul is very common and important also. It is used to prepare cotton-wool, mattresses and pillows. Tropical grasses like lemon grass, citronella, and khus and different wood species such as sandalwood, agar, and pine are the source of essential oils. Oil is also derived from the leaves of certain plants and trees such as eucalyptus, camphor, wintergreen, and pine. These oils are used for making soaps, cosmetics, incense, medicines and confectionery. Turpentine oil is used for medicine and varnish preparation. Sandalwood is also demanded for making carved boxes, toys, buttons etc. There are also uses of wood in chemicals. India exports teak, rosewood and sandalwood to U.S.A. and European countries. India exports lac to U.S.A. and U.K. Lac is used for making gramophone records, varnish, electric insulation sealing wax, lithographic ink etc. Resin is collected from the chir pines of the Western Himalayas. It is used for making resin and turpentine oil. It is demanded for shellac adulteration, in paper mills, soap factories etc. Myrobalan found in West Bengal, Tamil Nadu, Orissa, Maharashtra and Bihar is demanded for preparing different dyes, medicine etc. India exports myrobalans to England, U.S.A., Japan and other places.

Tropical evergreen rain forests are located in the areas of North-East India, Himalayan foot-hills, the western slopes of Western Ghats and Andaman Islands. These forests are very dense and composed of different species which are characterised by high economic value. These forests contain several valuable timber producing trees of great commercial value. Chaplash is important for furniture making, ship building, packing boxes manufacturing. Bishop-wood is demanded for the construction of bridges and houses. Poon is used for building of houses and making furniture. Toon is used in making furniture, tea boxes, toys etc. Rosewood is demanded for making gun-carriage wheels, wagon parts and by railways. Sissoo is important as furniture wood.

Monsoon deciduous forests are situated in the Himalayan foot-hills, central plateaus, and hilly areas in the eastern part of Deccan. These are important forests for yielding timbers and numerous forest products of high economic value. Sal is demanded for construction and domestic purposes. Teak is used for ship building and furniture making: Arjun is important concerning the making of agricultural implements, carts and boats. Andaman padauk is important for making billiard tables, railway carriage work, ship cabins and saloons. Kaaju is demanded for making furniture, shooks, match boxes, slate frames, cotton reels etc.

Tropical savannah is found to grow in the central portion of the Deccan plateau, Punjab, Uttar Pradesh and Rajasthan. These grasses produce high economic value: They are important for making ropes, thatching, and also as fuel. Saabai grass is used for rope making and as a raw material is required for paper industries.

Dry xerophytes forests are found in Rajasthan, parts of Punjab and Uttar Pradesh. They are used for making parts of carts, plough, harrows and clod crushers.

Coastal and deltaic forests consisting of mangroves are found in the Sunderbans in West Bengal, and

Mahanadi, Godavari, Krishna and Cauveri deltas. Important forest resources are fire-woods, honey tanning materials and certain timbers like sundari. Sundari is used for making boat and also as fuel.

Himalayan forests vary with elevation. The Himalaya contains terai forest, evergreen oak forest, coniferous forest and alpine forest. There have some important timber producing trees. Spruce is derived for planking, cheap furniture, boxes etc. Fir is demanded for paper pulp. Chir and blue pines are used for railway sleepers. Deodar is worked for railway sleepers and building construction.

- **4.8.3.2.3. Misuses**

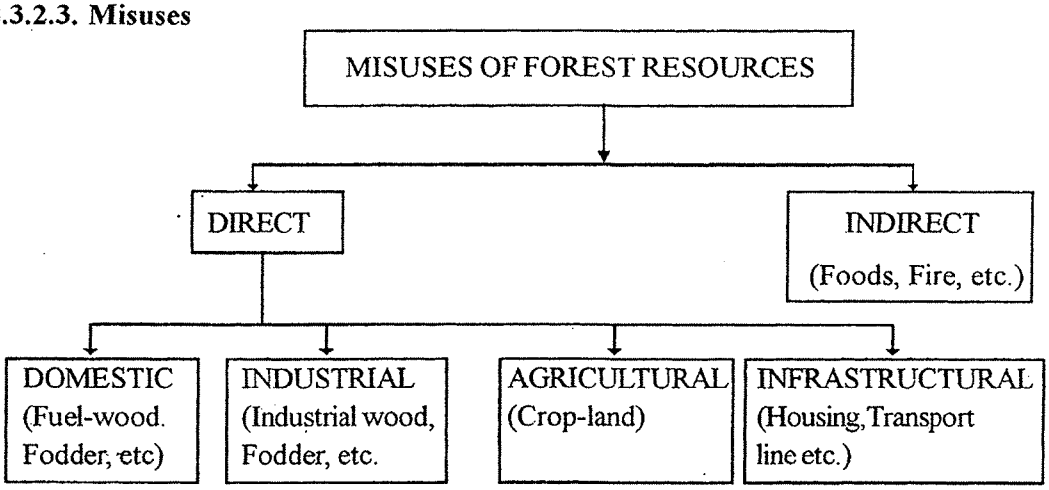

Figure: 2

At present forest resources are being destructed throughout the world. The forests are considered as one of the important parts in human ecology. Scientists have mentioned different reasons behind contraction of the forest resources. These are clearing of vast areas for the collection of forest products and utilising lands for crops, settlements and pastures. If we consider man and environment relationship in the forested lands and we look forward to the analysis of the resource-population relationships then it can be said that there is a limit beyond which more pressure exerted upon the forest resources, more environmental degradation will follow. Main cause of forest degradation is the pressure on forest resources beyond its tolerance and without much consideration for its sustainability. Misuse refers to the overexploitation of forest resources. Figure 2 shows that there are direct and indirect ways of misuses of the forest resources. Indirectly forests are degraded through floods, fire etc. Within the direct misuse there are domestic, industrial, agricultural and infrastructural activities. Over the years, as man himself has progressed to achieve economic development, the forest began to deplete gradually. It is due to man's dependence on the forest resources to collect several substances for the very purpose of that economic development. The dense forests are affected mostly and they are losing their productivity. Throughout the world, among the people, there is an increasing demand of timber, pulp-wood, fuel-wood and others. Forests are always disturbed, either by illegal logging or by subsistence farming. Forest areas have become wasteland within a few years due to frequent shifting cultivation. Standing trees of the forests have been destructed. So forests have been subjected to rapid exploitation. At present forest drain has exceeded the normal growth of the forests. In the coniferous forests, it has exceeded their growth by 20%. Saw timber drain is alarming and poses a serious problem exceeding the growth by 52°f° (Guha and Chattoraj, 2001). People exploited forest resources. through unscientific methods of collection of the forest products throughout the centuries. Its depletion affects it in return and the environment in addition. Finally the mother forest has been

degraded. Today,. the forest destruction has become an environmental issue. Though forest has renewability and timber is considered a flow resource but without its wise management it is depleted quickly. The trend of degradation of forests can be diminished only if this precious resource is managed sustainably.

▲ 4.8.3.2.3.1. World

Following the estimation made by the Smithsonian Institute, U.S.A., it is known that the *tropical rain forest* has been decreased at the rate of more or less one-crore hectares per year (Chattopadhyaya, 2006). The reasons are haphazardly cutting and felling of the trees, preparation of agricultural lands and pasture lands, and increasing population and increasing demand of the lands for settlements. Tropical forests disappear at the rate of 11.3 million hectares a year. Following Corson (1990), Chattopadhyaya (2006) has documented that about 80-1akh-hectare areas of the tropical rain forest have been burned in Brazil in the very near past. He also outlined that in Ivory Coast forests have been destructed by 66% of the total area in the last 25 years due to several reasons. Similarly, in Madagascar the amount of destruction of the forests is around 93%. In the coastal regions of the Brazil it is estimated that the amount of destruction is nearly about 99%. The FAO committee mentioned that different types of misuse lead to the degradation of forest resources and destruction of wildlife with their natural habitats. Finally these are resulting into depletion of genetic resources. American Forestry Association (1988) mentioned that forest resources are misused in the several, countries like Columbia, Ecuador, Brazil, Ivory Coast, Ghana, Madagascar, India, and Malaysia etc. According to their report there are different ways of misuse. These are commercial lumbering, urbanisation, collection of fire-wood, preparation of pasture lands, increasing plantation agriculture, hunting and gathering and so many.

Tropical deciduous forests are affected by increasing demand of lands for settlements and agriculture. Over exploitation of these forests due to over cutting and felling of trees, preparation of transport and communication lines, establishment of settlements, management of agricultural fields etc affects the forest system and the region in return. There the unexpected haphazard exploitation of trees leads to the environmental problems like soil erosion, floods etc.

Temperate forests also faced problems coming from the excessive destruction of the trees. Temperate zone is a dense populated region of the world. Maximum pressure comes from increasing demand of lands for settlements, transport lines and agriculture.

Coniferous forests are also affected by over exploitation due to increasing agriculture, urbanisation and industrialisation. In Europe, large-scale utilisation of these forests started around the mid-1800s. Initially, the natural forests were destructed in a similar way for mining. This destruction was the basis for the establishment of mills and surrounding communities.

▲ 4.8.3.2.3.2. India

At present, over the years, the area under forest cover has decreased steadily. Forests have been cleared for agriculture, industry, urbanisation, transport and communication, and due to hydroelectric plants. Generally forests are being converted to permanent settlements through felling a lot of trees. Now more than 40% of country's forest cover has been degraded. The exploitation of natural forest resources for timber, cropland, fuel-wood, pasture and housing has an impact on many poor rural families who depend on forest resources for fuel, fodder, food, medicine, furniture, housing etc. In India it is estimated that more than 1500 species of trees are commercially exploited for the collection of timbers. There more than 50% forest land is annually prone to fires causing a loss of Rs.440 crore (only replacement cost of seedlings).

In the British period trees were felled without any thought. Sal, teak and sandalwood were exported at that time enormously. The British government gradually appropriated forest resources for the revenue generation. During First World-War forest resources were severely exploited. In that period large quantities of timber were cut to build ships, railway sleepers and for other purposes. Second World-War made even greater demand on the timbers than the First World-War had done. After independence in 1947, a great upheaval in forest management had been occurred in India. A time was, when the Maharajas cut down a lot of their forests and sold them to earn more and more money. Besides these forests, there was a vast area of forest land existed. But they have been exploited since the central government took over these to states. Until 1976, the forest resources were recognised as a source of earning money. Therefore the state was spent little to protect the forest lands and to stop the misuses of forest resources. Table 1 shows different ways of loss of the forest lands in India after Independence.

Table: 1 Loss of forest area after independence, India

Serial	Purposes	Loss in million hectares
01	non-forestry activity	4696
02	illegal encroachment	0.07
03	cultivation	4.37
04	river valley projects	0.518
05	industries and townships	0.141
06	transmission lines and roads	0.061

Source: *http://edugreen.teri.res.in/explore/forestry/depletion.htm*

Different forest communities follow a method of slash and burn of the trees for Jhum cultivation. This method is commonly practised in the hilly regions. It causes extensive damage to the forest area. Different communities living in and around forest land remove fuel-wood from that forest. When the population of India was low, the forest had met the demand fruitfully. And, the environment was healthy also. But, when the number of population increases rapidly the forests are severely misused accordingly. India's human population constitutes about 16% of the world's population, whereas the geographical area is only 2.5%. There are some alternative sources for rural domestic energy like crop residues, animal dung, farm-wood, biogas, kerosene, solar and wind power etc to check the misuse of the forest resources. The degradation of forests has accelerated soil erosion, sedimentation of rive: flooding etc.

■ 4.8.3.3. CONCEPT OF SOCIAL FORESTRY AND JOINT FOREST MANAGEMENT

In the beginning of the analysis of social *forestry* and *joint forest management, in* order to understand their significance, it is important to view some of the basic objectives of the National Forest Policy of 1988 of India. These are as follows :

1. Maintenance of environmental stability and restoration of ecological balance of the forests which have been seriously affected and thus degraded.

2. Preservation of natural forests, enriched with vast variety of flora and fauna, which represent the remarkable biological diversity and genetic resources of the country.
3. Conservation of soil and water, especially through forests, in the catchment areas of rivers, lakes, reservoirs to mitigate floods and droughts.
4. Make available the requirements of fuel-wood, fodder, small timber etc to the rural and tribal population.
5. Enhancement of the productivity of forests to meet essential national needs.
6. Increment of the forest cover through massive afforestation and social forestry programmes, especially on all denuded, degraded and unproductive lands.
7. Creation of people's movement with the involvement of women toward joint forest management and to minimise pressure on existing forests.

● 4.8.3.3.1. Concept of Social Forestry

In India, according to the National Forest Policy, 1988, one-third of the geographical area should be sustained as forest. Here most of the rural inhabitants directly depend on the forest resources for their fuel-wood, fodder, and timber of different sizes for the agricultural and also for other requirements. They used forests to gather and extract forest products for their livelihood. Therefore, it is essential to afforest areas that are close to their settlements and which were degraded over the years due to different reasons. In 1976, the term *social forestry* was used by the National Commission on Agriculture, Government of India. Social forestry is the programme of afforestation of trees along the railway lines and roadways, rivers, canals etc; in and around the agricultural fields, schools, colleges, and other different governmental and non-governmental office buildings; in the village common lands, government wastelands, panchayet lands, and other places also. S. A. Shah (1988) has written that any programme of plantation of trees by any organisation on any type of land is a programme of social forestry which meets the needs of the rural people (Chattopadhyaya, 2006). The concept of social forestry is an integral part of the *Gandhian philosophy* of economic growth and community development. The government recognised the rights of the local people to use the forest resources and encouraged rural participation in the natural resource management with introduction of this programme. The government has involved the communities to participate in the programmes of social forestry and rehabilitating the degraded forests and also common lands. It has many differences from the conventional forestry. In conventional forestry there is not any kind of relation with the local people, but in a social forestry programme the aim is to satisfy the needs of the locals first. There is also some conceptual difference between production forestry like reserved forests and social forestry. It is not always necessary that the farmer grows trees for fuel-wood. But, very often they are interested in growing trees without any economic motive. Generally a hectare of plantation activity creates 150 to 500 man-days of employment during the first three years. Later, the harvesting of the forest-crop provides employment at a higher level of income for almost twice the number of man-days.

▲ 4.8.3.3.1.1. Salient Features

Social forestry found to organise in lands outside the conventional forest areas. It is a manmade forest. The areas for social forestry are the sides of railway lines, roadways, rivers, canals, creeks, and so on; in the village common lands, waste lands; in and around the schools,' colleges, agricultural lands etc. Important species for plantation are eucalyptus, aakashmoni etc.

▲ 4.8.3.3.1.2. Objectives and Importance

According to the National Commission on Agriculture, 1976, the significant objectives of social forestry are: (a) supply of fuel-wood to replace cow dung; (b) supply of small timber; (c) supply of fodder; (d) protection of agricultural fields from wind and soil erosion and; (e) creation of recreational amenities.

It is an afforestation programme where the main aim is to increase the number of trees. It enhances the yield of fuel-wood for domestic use. It confirms fodder for livestock, different forest products for local industries etc to ensure easy availability. It supplies small timbers for rural 'housing and to meet the agricultural requirements to the local people. Through this programme success agriculture is achieved improving the environment. It diminishes the threat of air pollution. The environmental system as well as the environmental balance is maintained in the areas of social forestry. Social forestry creates shelter belts against the natural calamities like floods and cyclones. It is advocated for reclaiming waste lands. It promotes the participation of institutions and people. Less fertile and unproductive lands are transferred to productive uses. It augments the income of poor rural people by tree planting. There are employment opportunities of the rural-poor-unskilled workers. It reduces the pressure for the forest products on the traditional forest areas. The natural beauty of an area has been enhanced by its implementation. It creates recreational forests for the benefit of rural and urban people. It is to increase the standard of living and quality of life of the rural and urban humans.

▲ 4.8.3.3.1.3. Different forms

Farm forestry: In the different countries social forestry programme is referred to as commercial and/or non-commercial farm forestry. Here individual farmers plant the trees in their own farmlands. It is to meet the domestic needs of their family. Farm forestry is characterised by different objectives. It is to attain self-sufficiency in fire-wood, small timber and fodder. It generates revenue by selling the extra fire-woods and other forest products. It conserves soil and water.

Community forestry: Community forestry refers to the plantation of trees on the community land. Here the main objective is to satisfy the entire community of the target area. It does not satisfy any individual person as well. The government has provided seeds, fertilisers etc to the community and the community has responsibility to protect the forest land from the misuses.

Extension forestry: It is the planting of trees on the sides of railways, roadways, rivers, canals, creeks etc. There a lot of fuel-woods have been created. Local rural people used them for their domestic purposes. Through extension forestry the existing forest boundary has been extended also.

Rural forestry: It refers to the forestry activities on community and village lands, degraded forests, sides of the railway lines and roads, on the banks of the rivers and canals for the benefit of the rural people. It also includes restored areas of quarrying, mining, road construction, brick manufacture etc. In general, forestry in the rural areas is considered as rural forestry. The objectives are more or less identical with the farm forestry, community forestry and extension forestry also. it is aimed to defeat poverty from the rural areas. In rural forestry the ownership is communal in character. There are multiple advantages for the rural population achieving food, fodder and subsidiary products.

Urban forestry: Urban forestry refers to the plantation of trees very near the home of the people. It is to improve the aesthetics of the local environment. The objectives of the urban forestry are planting trees along the road sides and canal banks near the towns and cities. It increases the beautification of domestic compounds, roads and

vacant lands.

Agro forestry : In India, according to the recommendations of the National Commission on Agriculture, the agro-forestry programmes were started in the late 1970s. Agro-forestry is defined as a sustainable land use system that increases the total yield by combining food crops together with the trees of the forests and livestock ranching on the same unit of land using management practices that take care of the social and cultural characteristics of the local people and the economic and ecological conditions of the local area. It reduces the farmers' dependency on the forest lands. It provides economic benefits to the rural people. It results in more diverse, healthy and sustainable land-use systems. It focuses on achieving the economic, ecological and domestic needs of people on their own lands.

● 4.8.3.3.2 Concept of Joint Forest Management

The concept of *Joint Forest Management* is popularly known as JFM programme. In India, it is now an important discourse in management of forest resources. It is estimated that the per capita forest area in India is only 0.08 hectare. But, the world's per capita forest area is about 0.64 hectare. Here the rural inhabitants depend on the forest resources to meet their livelihood needs. Another data shows that presently the per capita availability of forest biomass in the natural forests of the country is only about six ton, whereas in the developing countries the average is about 82 ton. It shows that there is a tremendous biotic pressure on the Indian forests. There nearly 23% of the total geographical area has been declared as forest lands. In the recent past the government policy was to use the forests for commercial purposes. Forests were exploited to satisfy commercial interests until 1988 for almost a century. This led to a direct confrontation between vested commercial interests and the interests of local communities. In India maximum forest lands are found in the uplands, mountains, and other such ecologically fragile areas. Inhabitants there mostly belong to the tribal communities and remain below the poverty line. They used forests to collect fuel-wood, fodder and other forest products which, in its turn, somewhat degrade the health of the forests under the current circumstances. As their livelihood supporting system is associated with forest resources, degradation of forests intensifies their poverty on the one hand, and puts more pressure on the fragile ecological system to further degradation on the other. Thus a vicious cycle is established. It is not the issue of sustainable environment versus rural poor forest dwellers. But to remove such a problem it should be seen as the struggle for survival of the poor people. In 1970, the West Bengal foresters resolved in a conference that the needs of the local communities are to be met first and then only the remaining surplus is to be auctioned off. All the local people need to get involved in the protection and development of forest resources and, as a result, JFM Programme has come out as an important concept for sustainable forest management. JFM refers the partnership in forest management for the development of a forest region involving both the state forest departments and the local communities. It is the process of institutionalising local people's participation in forest protection and regeneration. In 1971, the JIM programme in the present form was started first at the Arabari forest range in the district of Paschim Medinipur of the state of West Bengal. *Ajit Kumar Banerjee,* a silviculturalist, the then Divisional Forest Officer of the Department of Forest, Government of West Bengal, was the pioneer of the programme. He took initiatives for making provisions so that the forest resources may be shared between the government and the local people. The initial programme involved 612 families covering an area of about 12.7 square kilometres of degraded forests. Local villagers received the share of about 25% of the profits from the adopted forests. It was a successful step of the forest management and was found to set up in the other parts of the state in 1987. A few years later it was employed in the state of Haryana to prevent deforestation and resultant soil erosion. After the initial successes in West Bengal and Haryana, the JFM schemes received national importance. The official ground for JFM has been prepared by the National Forest Policy of 1988 which envisaged people's involvement, particularly of women, in meeting their basic forest related needs and in managing

their local resources. Following it, in 1990, JFM guidelines have been formulated by the Ministry of Environment and Forests to involve village communities and voluntary agencies in regeneration of degraded forests for the further journey. It is proposed that about 60% of the land in the hills and 20% in the plains and in all around 33% of the total geographical area in our country should be under forest cover. It is. due to sustainable management of the forest resource. In the year of 2005, there were 27 states. with various JFM schemes containing over 63000 FPCs involved in the joint management of over 1,40,000 square kilometres of forested land.

● 4.8.3.3.2.1. Favourable Factors

As mentioned by the Society for Promotion of Wastelands Development, 1992, important favourable factors for Initiating JFM are as follows :

1. Homogeneity of user community.
2. High degree of dependence on forest resources.
3. High stakes in protection.
4. Presence of good root stock.
5. Cultural and social moves favourable to community initiatives.
6. Compatible land/man ratio to meet local needs.
7. Favourable attitudes of local Forest department personnel.
8. Local leadership or the presence of NGO.
9. Old settlement and tenure relations compatible with village management.

▲ 4.8.3.3.2.2. Objectives and Importance

The primary objective of the JIM programme is to involve the local communities in planning, managing and protecting forests and to provide them some share of the benefits from these forests. The programme aims to empower local people for their active participation as partner in the management of forest resources. JFM is a concept to develop responsibilities of communities of the forest fringe for environmental protection and economic development. It is based on the partnership between forest department and local forest users on the basis of jointly defined activities. In India, JFM is gradually expanding as a powerful substance of sustainable forestry. The central view of this concept is to establish institutions of the grass-root communities for protection and management of the forests. It also aims to search technical and managerial capability available at the grass-root level of the local communities. It is said that the JIM approach optimises the returns and minimises conflicts, and links the works concerning forestry development with the total development of the land based resources. It is characterised by the principle of *care and share*. Success of the JFM programme depends upon the commitment of all the stake holders and aims to forest protection and development. Its success has been observed mostly in the areas of scarcity of the biomass resources and where developmental activities are linked with the JFM programme. Though there are various emerging issues, but to strengthen the JFM programme important guidelines of the centre to the state government on 21.02.2000 were as follows:

1. Legal backup to the JIM committees.
2. Participation of women in the JIM programme.
3. Extension of JIM in good forest areas.
4. Preparation of micro plan in JFM areas.
5. Recognition of self-initiated groups.
6. Contribution for regeneration of resources.

▲ 4.8.3.3.2.3. Extent of Area under JIM Programme

In India, from the year of 1990, the JIM programme has been implemented on a large scale. The Tenth-Five Year Plan proposed that JFM should cover all the forest fringe villages through the forest development agencies. Now more stress is being laid to increase the number of committees and to cover more areas under the JFM programme. At present the JFM scheme has been widely accepted within 22 states of the country based on the 1990guidlines of the Government of India. These states are Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Gujarat, Himachal Pradesh. Haryana, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Mizoram, Nagaland, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal. In 2000, there were a total of about 1, 02, 48, 586.41 hectares areas under JFM programme and the total number of JFM committees to protect and manage the forest lands was 36130. Madhya Pradesh had the maximum number of JFM committees (12038) and areas under JFM programme (58-lakhs hectares). Table 2 shows some statistics relating to the JFM programmes.

Table 2: Recent state-wise some aspects of JFM programmes

State	Number of JFM committees	Area under JFM (in hectares)	No.of families involved			Total no. of families involved in JFM
			SC	ST	General	
Andhra Pradesh	7606	1679084.00	244655	414650	-	659305
ArunachalPradesh	3	5810.00.	-	766	-	766
Assam	245	6970.00	3179	-	1495	4674
Bihar	296	504602.50	-	-	-	NA
Chhattisgarh	6412	3391305:31	76920	233585	161017	471522
Goa	26	13000.00	36	-	300	336
Gujarat	1237	138015.19	1124	101890	3495	106509
Haryana	471	65852.42	1612	0	7950	9562
HimachalPradesh	914	111247.20	9973	159	35098	45230
Jammu Kashmir	1895	79546.00	-	-	-	NA
Jharkhand	1379	430463.00	-	-	-	NA
Karnataka	2620	185000.00	15800	9600	44200	69600
Kerala	32	4994.70	781		2841	3622
Madhya Pradesh	9203	4125837.00	177272	429307	259323	865902
Maharashtra	2153	686688.00	35877	41000	25626	102503
Manipur	58	10500.00	-	-	-	NA
Mizoram	129	12740.00	-	-	-	NA
Nagaland	55	150000.00	-	550	-	550
Orissa	12317	783467.00	-	-	-	NA
Punjab	188	97193.40	4429	0	4973	9366
Rajasthan	3042	309336.00	55724	132133	84641	272498

Sikkim	158	600.00	669	835	1764	3268
Tamil Nadu	799	299389.00	43323	-	104497	147820
Tripura	160	23476.79	716	5804	1783	8303
Uttar Pradesh	502	45025.44	-	-	-	NA
Uttaranchal	7435	606 "'J'8.00	-	-	-	NA
West Bengal	3545	4$8095.00	-	-	-	NA
TOTAL	**62890**	**14254845.95**	**672090**	**1370279**	**738967**	**2781336**

Source: http://envfor.nic.in/divisions/forprt/jfm/html/area.htm

■ 14.8.3.4. AGRICULTURAL RESOURCES: ROLE TO MEET THE NUTRITIONAL REQUIREMENTS OF THE WORLD POPULATION. SUPPLY RAW MATERIALS FOR THE INDUSTRIES, ALTERNATIVE CONSERVATION AND ALTERNATIVE METHODS OF PRODUCTION :

Agriculture is played a key role to the socio-economic development of a nation. It is treated as a resource in every sense of the term. It is a renewable resource with great importance. Agricultural activity is considered as *primary activity*. The practice of agriculture is also known as *farming*. At present, throughout the world, nearly about one-third of the total workers are employed in the agricultural sector. *Agriculture* is the process through which foods, fibres, fuels, raw materials, pharmaceuticals and stimulants, and different types of ornamental products are obtained. And, it is the raising of domesticated animals (livestock) as well. Foods include cereals, vegetables, fruits etc. Fibres include jute, cotton, wool, silk etc. Raw materials are lumber, bamboo, and more others. Stimulants include tobacco, alcohol, cocaine etc. Bio-fuels include methane from biomass, biodiesel. Cut flowers, nursery plants, fishes, birds for the pet trade etc are some of the ornamental products. Therefore, agricultural products are crown significant for our life and livelihood also.

Based on agricultural resources several agro-based industries are found to develop enormously. Throughout the world with the increasing population, there is an increasing demand of these resources to meet the food and nutrient requirements of human beings. When demand exceeds production, in order to get more crops the people ---- directly as well as indirectly----- invite pollution in the processes of agricultural production systems. Generally, in the contemporary period, synthetic fertilisers and chemical pesticides are being used in abundance to grow more and more agricultural crops. The expansion of agriculture affects natural systems and causes disruption therein. Therefore ; there is need of alternative conservation and alternative methods of productions in the agricultural system as well Liberian agriculture can be divided into three distinct patterns of production. These are concessions, commercial farms, and traditional farms. There are differences considering organisation, efficiency and output.

● 4.8.3.4.1. Role to Meet the Nutritional Requirements of the World Population

Agricultural activities acquire an important role in providing food security and in the economy of a region. All over the world, large numbers of people are engaged in agricultural sector than in any other. But it only accounts for four percent of the world's GDP. World population has grown from 1.6 billion in 1900 to an estimated 6.8 billion today. Table 3 shows the world population of some of the selected years. In 2000, the United Nations estimated that the world population was growing at the rate of 1.14% or about 75 million people per year. The world population, following its current growth trajectory, is expected to reach nearly nine billion by the year 2042. According to population projections, world population will continue to increase until around 2050. Asia accounts for over 60% of

the world population. China and India alone stand for 20% and 17% share respectively. In the 20th century, there was maximum increase in the world population due to lessening of the mortality rate in many countries. It was also due to medical advances and massive increase in agricultural productivity ascribed to the Green Revolution. It is estimated that today industrial agriculture feeds 6000 million people. Nearly about 300 years ago intensive agriculture fed 600 million people. And, about 3000 years ago primitive agriculture fed 60 million people. Throughout the world, food consumption has amplified steadily since 1960. There are remarkable differences among the different countries considering the amount, variety and quality of food. In the Near East Countries agricultural production grew dramatically a few years ago, and it is found that the increasing production helped the high growth rate of consumption therein. Once India was highly dependent on food aid, but today it has become an exporter of food. Consumption of agricultural resources in the developing countries grew modestly during the last six decades. However, in the beginning af, that period, the modest growth combined with low levels of consumption caused the gap to be expanded in per capita food consumption between developed and developing countries. In the developing countries rapid growth of population is the main constraint to improve the status of food consumption. Population increases in these countries rapidly than those of the rest of the world. In Asia the vast majority of the population are rural and poor but the growth of the middle class is dramatic here. With the [illegible]g lifestyle and food habits there is an increasing demand for greater variety of foods, leading to grow greater [illegible] of agricultural resources. Since 2006 the growth of the total grain utilisation has been found to increase in non [illegible]od sectors also like feeds, bio-fuels etc. These different types of demands lead to increase the commodity prices. The gradual changes in diet among newly prosperous population are the most important factor underpinning the rise in global food prices. Table 4 shows top ten agricultural products by the crop types and also by the individual crops with their amount of productions according to the Food and Agriculture Organisation (FAO), 2007. Table 5 shows, as Joachim von Braun (2008) calculated, 2005/1990 ratios of per capita consumption by the people of some selected countries considering some of the selected crop types. Consumption of every crop types increases more or less in every country. In China, consumption of foods increases dramatically except only the cereals. In India also cereals consumption remains unchanged, though the population has been increased in both the countries. As population increases there is a change in the composition of people's diets with the amounts of their consumed foods. When income rises further, people are likely to eat more animal products, fruits and vegetables. It is not only to improve the quality of their diets but also to elevate their status in the eyes of others. However, when people consume different types of foods then their diet becomes more nutritionally balanced. According to the World Resources Institute, global per capita food production increases substantially. There are two basic criteria by which one can judge humanity's success in feeding itself: 1) the proportion of people whose access to basic nutritional requirements is secure; and Z) the extent to which global food production is sustainable.

In 1977, the International Fund for Agricultural Development (IFAD), a specialised agency of the United Nations, was established as one of the major outcomes of the 1974 World Food Conference to act as an international financial institution. IFAD is dedicated to eradicate rural poverty in the developing countries. There live about 75 % of the world's poor in the rural areas, yet only four percent of official development assistance benefits to the agriculture. Most of the world's poor people live in the rural backwaters of Africa, Asia and Latin America. Most of them are small farmers and/or landless farm workers. The prices of basic food commodities are increased rapidly. In 1974 there was a rise in food prices. Since 2006 price of the rice has been increased moderately while the prices of wheat and maize have been increased rapidly. Thus the problem increases stridently to food security in the developing countries. Therefore it is essential for coordinated action by the international community and by the United Nations

in particular. *Food security* refers to the availability of food and one's access to it. According to FAO (2003), throughout the world, nearly about 852 million people are chronically hungry due to extreme poverty and up to two billion people belong to lack of food security intermittently due to varying degrees of poverty. Food riots are found to happen in many countries across the world.

Table 3: World Population

UN estimates (in thousands)							
Year	**World**	**Africa**	**Asia**	**Europe**	**Latin America**	**US and Canada**	**Oceania**
		795,671	3,679,737	727,986	520,229	315,915	31,043
2000	6,070,581						
		(13.1%)	(60.6%)	(12.0%)	(8.6%)	(5.2%)	(0.5%)
		887,964	3,917,508	724,722	558,281	332,156	32,998
2005	6,453,628						
		(13.8%)	(60.7%)	(11.2%)	(8.7%)	(5.1%)	(0.5%)
		984,225	4,148,948	719,714	594,436	348,139	34,821
2010	6,830,283						
		(14.4%)	(60.7%)	(10.5%)	(8.7%)	(5.1%)	(0.5%)
		1,187,584	4,570,131	705,410	659,248	379,589	38,275
2020	7,540,237						
		(15.7%)	(60.6%)	(9.4%)	(8.7%)	(5.0%)	(0.5%)
		1,803,298	5,217,202	653,323	767,685	447,931	45,815
2050	8,918,724						
		(20.2%)	(58.5%)	(7.3%)	(8:6%)	(5.0%)	(0.5%)

Source: *Wilipedia (world population)*

Table 4: Top ten agricultural products of 2004

FAO estimates (in million metric tons)			
by crop types		**by individual crops**	
Crops	**Production**	**Crops**	**Production**
Cereals	2,263	Sugar Cane	1,324
Vegetables and melons	866	Maize	721
Roots and tubers	715	Wheat	627
Milk	619	Rice	605
Fruit	503	Potatoes	328
Meat	259	Sugar Beet	249
Oil-crops	133	Soybean	204
Fish (2001 estimate)	130	Oil Palm Fruit	162
Eggs	63	Barley	154
Pulses	60	Tomato	120

Source: FAOSTAT *in Wikipedia (agriculture)*

Table 5: 2005/1990 ratios of per capita consumption

Products	India	China	Brazil	Nigeria
Cereals	1.0	0.8	1.2	1.0
Meat	1.2	2.4	1.7	1.0
Milk	1.2	3.0	1.2	1.3
Fish	1.2	2.3	0.9	0.8
Fruits	1.3	3.5	0.8	1.1
Vegetables	1.3	2.9	1.3	1.3

Source: *Joachim von Braun, 2008*

● 4.8.3.4.2. Raw Materials for the Industries

Agro-based industries are useful and important for the economic development of a nation. These occupy an important place both in respect to their output and the employment opportunities which they have provided. Outcomes of the agricultural activities are further used as raw materials in the secondary economic activities i.e. in the industries. Agro-based industries can be broadly divided into three major types. These are *food industries, fibre industries* and *other industries.* Table 6 depicts concisely names of some of the agro-based industries and their raw materials for processed. Industrially useful compounds derived from agricultural products include cereals, vegetables, fruits, spices, sugar and beverages, industrial crops like rubbers, fibres etc, and fats and oils, fumitory like tobacco, fisheries, and pastoral resources such as milk, meat, wool etc. New crops for the industrial purposes can be obtained from the domestication of wild species of plants also. Cuphea, an oilseed that could replace coconut oil, is an example of an attempt to domesticate a wild species.

Table 6: Agro-based Industries and their Raw Materials

Broad Types	Name of the Industries	Raw Materials
Food industries	Bakery	wheat
	Rice-mill	rice
	Sugar industry	sugarcane and sugar-beat
	Vegetable oil industry	sunflower seed, ground nut, soyabean, coconut etc
	Spice industry	turmeric, ginger, black pepper, saffron etc
	Fruit juice industry	fruits like mango, apple etc
	Wine industry	fruits (gape), flowers (cowslip), cereals (rice) and vegetables (potato)
	Plantation industry	tea, coffee etc
	Pastoral farming	animals like cow, buffalo, sheep etc

	Dry-food industry	I cereals, vegetables, fish, meat, and others
Fibre industries	Cotton textile	cotton
	lute textile	jute
	Woollen textile	animal fibre
	Silk industry	caterpillar of certain moths
Other industries	Leather industry	animals
	Rubber industry	natural rubber (latex)
	Paper industry	sugar cane
	Cottage industry	cotton, wool, flux etc
	Fumitory industry	tobacco

Throughout the world different food crops are obvious raw materials for several food *industries.* These industries have much importance than the others. Wheat is cultivated in the

countries like China, India, U:S.A., France etc. It is found to use its different parts in the industries of-foods, papers and others. Rice is another important cereal of several countries of Asia, Africa and Europe: Its different parts are used also to produce different kinds of foods, wine, soaps, boards etc. Sugar-cane is an important cash crop. It is used to produce sugar, wine, paper, wax, board, artificial rubber etc. All over the world, Brazil and India produce sugar-cane more than 50% of the total in combination. Oilseed crops are the major source of oils and fatty acids. These are used for industrial purposes. Most common sources of industrial fatty acids are coconut oil, palm oil, sunflower, soybean oil etc. Fats and oils are used in the selective industries like' soaps, detergents, paints, vanishes, plastics and others. Industrial rapeseed is an oilseed that produces a chemical which is valuably used as a slip agent within some plastics. It is now cultivated in many countries as well. In tropical and subtropical countries spice plants grow and important as flavourings for food. Spices like ginger, chilli, pepper, vanilla etc are not only used in making cook but also are used as additives in the preserving of food and canning industries. In Europe, particularly within the Mediterranean climatic regions, industries in connection with fruits and alcohol are in abundance. In India, tea estates are found in the hilly regions of Darjeeling of the state of West Bengal, Assam, Uttar Pradesh, Kerala, Tamil Nadu, Karnataka and other places, and there based on tea plantations, industries are found to service. Coffee is another plantation crop encouraging establishment of coffee industry. It is found to plant in the countries like Brazil, Columbia, Indonesia etc. In India, it is obtained from the states of Kerala, Karnataka and Tamil Nadu. Pastoral farming is the rearing of animals for the production of meat, milk and wool. It is mostly developed in the countries of Europe, U.S.A. and Australia etc. Based on cereals, vegetables etc, different types of industries for the preparation of dry-foods are observed worldwide. In the context of *fibre industries,* cotton is an important fibre-crop cultivated in the countries like China, India, Pakistan, U.S.A. and others. In India, cotton is derived from the states of Gujarat, Maharashtra, Punjab, Karnataka, Tamil Nadu, Madhya Pradesh etc. It is the chief raw material for the cotton textile industry. Here jute is another fibre-crop cultivated in the states of West Bengal, Assam, Orissa, Bihar and others. It is used in the jute industry to manufacture different items of jute like carrying bags, ropes and many others. Other fibre-crops like wool and silk are used to manufacture different kinds of clothes, especially

warm cloths. Besides, throughout the world, there are *other industries* based on agricultural products with great importance also. These are leather industry, rubber industry, paper industry, cottage industry and fumitory industry.

Industrial agriculture is a form of modern farming that refers to the industrialised production of livestock, poultry, fish and crops. The methods of industrial agriculture are techno-scientific, economic and political. They include innovation in agricultural machinery and fanning methods, genetic technology, techniques for achieving economies of scale in production, the creation of new markets for consumption, the application of patent protection to genetic information and global trade. These methods are widespread in developed countries and prevail worldwide. Most of the meat, dairy, eggs, fruits and vegetables available in supermarkets are produced using these methods of industrial agriculture.

● 4.8.3.4.3. Alternative Conservation and Alternative Methods of Production

Agriculture and Conservation are two separate things. Though they are different and seem unlikely but can coexist together. According to the New Standard Encyclopaedia (1992), agriculture is considered the most important sector in the economies of most of the nations. At the same time conservation refers to the use of resources in a manner that safely maintains a resource which can be used by the people. As the world population increases rapidly, there needs more food to be produced every year. In this context conservation has become more critical. Many agricultural practices have an off-farm impact on our society and environment also. In general agriculture is characterised by enhanced productivity, the use of synthetic fertilisers and pesticides, selective breeding, mechanisation, water contamination and farm subsidies. It is found that agriculture creates serious environmental problems. It supplies sediments, salts, fertilisers, pesticides and manures to the water bodies to be polluted. It is the largest single nonpoint source of water pollution. In several farming regions, common agricultural practices have degraded surface-water quality in abundance and to a lesser degree groundwater quality also. In recent years, scientists have recognised that off-farm costs of agricultural practices must be reduced. The costs associated with the use of chemical pesticides, synthetic fertiliser applications and tillage methods.

▲ 4.8.3.4.3.1. Concept of Alternative Agriculture

Current scientific, technological, economic, social and environmental trends are the factors underpinning the reconsideration of the practices of the farmers and look for alternatives. *Alternative.agriculture is* a systematic approach to reduce agricultural pollution, enhance sustainability, and improve efficiency and profitability. It is not any single system of fanning practices. It includes different farming systems. It does not indicate to the farming systems which are popularly known as biological, low-input, organic and sustainable. It has wide connotations whereas the latter are limited by their properties. Sustainable agriculture integrates three main goals such as environmental stewardship, farm profitability, and prosperous farming communities. But, alternative agriculture emphasises management practices of natural processes----nutrient cycles, nitrogen fixation, and pest-predator relationships. It includes a range of practices such as: Integrated Pest Management (IPM); low-intensity animal production systems; crop rotations designed to reduce pest damage, improve crop health, decrease soil erosion, and in the case of legumes fix nitrogen in the soil; and tillage and planting practices thaL reduce soil erosion and help to control weeds. It integrates the match between cropping patterns and agronomic practices on the one hand and the productive potential and physical characteristics of the land on the other, and make selective use of commercial fertilisers and. pesticides to ensure production efficiency, and conservation of soil, water, energy' and biological resources. Alternative system encompasses the biological and ecological interactions, nutrient cycles and.management'systems toward sustaining and maximising on-farm resources. It involves organic systems- that attempt to use no purchased synthetic

chemical inputs. It also characterised by the power of prudence in use of pesticides or antibiotics to control specific pests or diseases. Farmers can reduce pesticide use through rotations. Rotation disrupts the reproductive cycle, habitat and food supply of many crop insect pests and diseases. Farmers reduce the application rates of nitrogen fertilisers by altering the timing and placement with little or no sacrifice in crop yields. Successful alternative farmers require more information and management skills to reduce costs, trained labour, and improve efficiency per unit of production than conventional farming. Alternative agriculture refers to those farming practices that go beyond the conventional agriculture. But its base remains on conventional practices that are consistent with the overall system. The success of alternative farmers encourages many other farmers and it potentially significant benefits the nation. Economic performance of alternative agriculture can be improved in several ways. These are as follows:

- Lowering per unit expenditures on production inputs.
- Increasing output per unit of input.
- Producing more profitable crops and livestock.
- Reducing capital expenditures on machinery, irrigation equipment and buildings.
- Reducing natural crop and animal losses.
- Reducing income loss through commodity price fluctuations.
- Making fuller use of available land, labour, and other resources.

▲ 4.8.3.4.3.2. Objectives

Main objectives of the alternative agriculture are as follows :

1. Incorporation of natural processes such as nutrient cycles, nitrogen fixation and pest-predator relationships in the agricultural production system.
2. Decrease of off-farm inputs to eradicate harmful influences on the environment and to protect the health of farmers and consumers.
3. Increase the use of thr biological and genetic potential of plant and animal species.
4. Improve the relation between cropping patterns, the productive potential and physical constraints of agricultural lands to ensure long-term sustainability of current production level.
5. Augmentation of vertical and horizontal level of profit.
6. Development of farm management and conservation of soil, water, energy and biological resources.

▲ 4.8.3.4.3.3. Methods

Definition of alternative agriculture encompasses important methods to practise. Alternative agriculture contains a range of farming methods like use of crop rotations, and animal and green manures; IPM; biological and cultural pest control; use of organic materials to improve soil quality; soil and water conserving tillage systems; and use of genetically improved crops and animals that involve less reliance on antibiotics and confinement. Alternative system developed and used biological interactions rather than reduces and suppresses them. Alternative methods require careful attention to attend good outcomes. For instance, the process of crop rotation of legumes with grain crops increases soil nitrogen, but the enrichment varies depending on soil chemistry, tillage and legume variety. Manure supplies nitrogen, phosphorus, potassium and other nutrients to soil, but nutrient availability depends on storing and spreading methods. Wide adoption of these methods requires more or less equal profit as conventional methods. It

is also important that there should remain nonmonetary advantages like preservation of rapidly deteriorating soil and/ or water resources. Now we are going to analyse some of the important methods practised within the alternative agriculture.

Crop rotations: It is the process of successive planting of different crops in the same field. It diminishes weed disease, insect and other pest problems. It enhances the availability of soil nitrogen therein. It is the process which reduces the need of purchased fertilisers in the agricultural production system. It reduces soil erosion in conjunction with tillage practices. For instance, corn followed by soybeans, followed by oats, followed by alfalfa. Rotations are the opposite of continuous cropping. The life time of rotations may range between two to five years or sometimes more. Farmers generally involve a part of their land to each crop in the rotation. It provides economic and environmental benefits to the agricultural producers.

Integrated Pest Management (IPM): It is an important method practised within the alternative agricultural system. It reduces the need of pesticides following crop rotations, scouting, weather monitoring, use of resistant cultivars, timing of planting, and biological pest controls. There are different biological pest control techniques used in IPM systems. These include the use of pest predators or parasites, selection of pest-resistant plant cultivars, use of insect pheromones, release of sterile males, immunisation of host plants and use of bacterial insecticides.

Management systems: There is a need of good management system to control weeds and to improve the health of the plants. It is necessary for the crops to resist insect pests and diseases.

Soil-and water-conserving tillage: Soil, water and air supply the chemical elements which are needed for the proper plant growth. Plants need three soil-derived nutrient elements in large amounts. These are nitrogen, phosphorus and potassium. These elements are frequently not available in sufficient amounts from the soil.

Livestock rearing: It plays an important role in relation with the nutrient cycling and crop rotation. There are *animal production systems* that emphasise disease prevention through health maintenance. These are practised to reduce the need of antibiotics.

Genetic improvement of crops: It is to resist insect pests and diseases, and to use nutrients more effectively.

■ 4.8.3.5. SELF ASSESSMENT QUESTIONS

1. What do you mean by forest resources? Discuss in brief uses and misuses of forest resources with special reference to the tropical forests.
2. What is social forestry? What are ihe basic needs of social forestry in India?
3. Define JFM programme. Write a short note on JFM programmes in India.
4. How do you correlate agricultural resources with the nutritional problem throughout the world?
5. Which agricultural resources are used as raw materials for industries? Discuss with suitable examples such agricultural resources and associated industries in India.
6. What is alternative agriculture? Write about importance and methods of alternative agriculture.

■ 4.8.3:6. REFERENCES

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"Learner's Feed-back"

After going through the Modules/ Units please answer the following questionnaire.
Cut the portion and send the same to the Directorate.

To
The Director
Directorate of Distance Education,
Vidyasagar University,
Midnapore- 721 102.

1. The modules are : (give ✓ in appropriate box)
   ☐ Easily understandable; ☐ very hard; ☐ partially understandable.
2. Write the number of the Modules/Units which are very difficult to understand :
   .....
   .....
   .....
3. Write the number of Modules/ Units which according to you should be re-written :
   .....
   .....
   .....
4. Which portion/page is not understandable to you? (Mention the page no. And Portion)
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   .....
5. Write a short comment about the study material as a learner.
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(full Signature of the Leaner)

Enrolment No. .....

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