GIST OF N.C.E.R.T

SOILS

Soil is the most important layer of the earth's crust. It is a valuable resource.

Soil is the mixture of rock debris and organic materials which develop on the earth's surface. The major factors affecting the formation of soil are relief, parent material, climate, vegetation and other life-forms and time. Besides these, human activities also influence it to a large extent. Components of the soil are mineral particles, humus, water and air. The actual amount of each of these depend upon the type of soil. Some soils are deficient in one or more of these, while there are some others that have varied combinations.

If we dig a pit on land and look at the soil, we find that it consists of three layers which are called horizons. 'Horizon A' is the topmost zone, where organic materials have got incorporated with the mineral matter, nutrients and water, which are necessary for the growth of plants. 'Horizon B' is a transition zone between the 'horizon A' and 'horizon C', and contains matter derived from below as well as from above. It has some organic matter in it, although the mineral matter is noticeably weathered. 'Horizon C' is composed of the loose parent material. This layer is the first stage in the soil formation process and eventually forms the above two layers. This arrangement of layers is known as the soil profile. Underneath these three horizons is the rock which is also known as the parent rock or the bedrock. Soil, which is a complex and varied entity, has always drawn the attention of the scientists.

Classification of Soils

India has varied relief features, landforms, climatic realms and vegetation types. These have contributed in the development of various types of soils in India.

On the basis of genesis, colour, composition and location, the soils of India have been classified into: (i) Alluvial soils, (ii) Black soils, (iii) Red and Yellow soils, (iv) Late rite soils, (v) arid soils, (vi) Saline soils, (vii) Peaty soils, (viii) Forest soils.

ICAR has classified the soils of India into the following order as per the USDA soil taxonomy

Sl.No.	*Order*	*Area (In Thousand Hectares)*	*Percentage*
(i)	Inceptisols	130372.90	39.74
(ii)	Entisols	92131.71	28.08
(iii)	Alfisols	44448.68	13.55
(iv)	Vertisols	27960.00	8.52
(v)	Aridisols	14069.00	4.28
(vi)	Ultisols	8250.00	2.51
(vii)	Mollisols	1320.00	0.40
(viii)	Others	9503.10	2.92
	Total		100

Source: Soils of India. National Bureau of Soil Survey and Land Use Planning. Publication Number 94

Alluvial Soils

Alluvial soils are widespread in the northern plains and the river valleys. These soils cover about 40 per cent of the total area of the country. They are depositional soils, transported and deposited by rivers and streams. Through a narrow corridor in Rajasthan, They extend into the plains of Gujarat. In the Peninsular region, they are found in deltas of the east coast and in the river valleys.

The alluvial soils vary in nature from sandy loam to clay. They are generally rich in potash but poor in phosphorous. In the Upper and Middle Ganga plain, two different types of alluvial soils have developed, viz. Khadar and Bhangar. Khadar is the new alluvium and is deposited by floods annually, which enriches the soil by depositing fine silts. Bhangar represents a system of older alluvium, deposited away from the flood plains. Both the Khadar and Bhangar soils contain calcareous concretions (Kankars). These soils are more loamy and clayey in the lower and middle Ganga plain and the Brahamputra valley. The sand content decreases from the west to east.

The colour of the alluvial soils varies from the light grey to ash grey. Its shades depend on the depth of the deposition, the texture of the materials, and the time taken for attaining maturity. Alluvial soils are intensively cultivated.

Black Soil

Black soil covers most of the Deccan Plateau which includes parts of Maharashtra, Madhya Pradesh, Gujarat, Madhya Pradesh, Gujarat, Andhra Pradesh and some parts of Tamil Nadu. In the upper reaches of the Godavari and the Krishna, and the north western part of the Deccan Plateau, the black soil is very deep. These soils are also known as the 'Regur Soil' or the 'Black Cotton Soil'. The black soils are generally clayey, deep and impermeable. They swell and become sticky when wet and shrink when dried. So, during the dry season, these soils develop wide cracks. Thus, there occurs a kind of 'self ploughing'. Because of this character of slow absorption and loss of moisture, the black soil retains the moisture for a very long time, which helps the crops, especially; the rain fed ones, to sustain even during the dry season.

Chemically, the black soils are rich in lime, iron, magnesia and alumina. They also contain potash. But they lack in phosphorous, nitrogen and organic matter. The colour of the soil ranges from deep black to grey.

Red and Yellow Soil

Red Soil develops on crystalline igneous rocks in areas of low rainfall in the eastern and southern part of the Deccan Plateau. Along the piedmont zone of the Western Ghat, long stretch of area is occupied by red loamy soil. Yellow and red soils are also found in parts of Orissa and Chattisgarh _and in the southern parts of the middle Ganga plain. The soil develops a reddish colour due to a wide diffusion of iron in crystalline and metamorphic rocks. It looks yellow when it occurs in a hydrated form. The fine-grained red and yellow soils are normally fertile, whereas coarse-grained soils found in dry upland areas are poor in fertility. They are generally poor in nitrogen, phosphorous and humus.

Laterite Soil

Laterite has been derived from the Latin word 'Later' which maens brick. The laterite soils develop in areas with high temperature and high rainfall. These are the result of intense leaching due to tropical rains. With rain, lime and silica are leached away, and soils rich in iron oxide and aluminum compound are left behind. Humus content of the soil is removed fast by bacteria that thrives well in high temperature. These soils are poor in organic matter, nitrogen, phosphate and calcium, while iron oxide and potash are in excess. Hence, laterites are not suitable for cultivation; however, application of manures and fertilizers are required for making the soils fertile for cultivation.

Red laterite soils in Tamil Nadu, Andhra Pradesh and Kerala are more suitable for tree crops like cashew nut.

Laterite soils are widely cut as bricks for use in house construction. These soils have mainly developed in the higher areas of the Peninsular plateau. The laterite soils are commonly found in Karnataka, Kerala, Tamil Nadu, Madhya Pradesh and the hilly areas of Orissa and Assam.

Arid Soils

Arid soils range from red to brown in colour. They are generally sandy in structure and saline in nature. In some areas, the salt content is so high that common salt is obtained by evaporating the saline water. Due to the dry climate, high temperature and accelerated evaporation, they lack moisture and humus. Nitrogen is insufficient and the phosphate content is normal. Lower horizons of the soil are occupied by 'kankar' layers because of the increasing calcium content downwards. The 'Kankar' layer formation in the bottom horizons restricts the infiltration of water, and as such when irrigation is made available, the soil moisture is readily available for a sustainable plant growth. Arid soils are characteristically developed in western Rajasthan, which exhibit characteristic and topography. These soils are poor and contain little humus and organic matter.

Saline Soils

They are also known as Usara soils. Saline soils contain a larger proportion of sodium, potassium and magnesium, and thus, they are infertile, and do not support any vegetative growth. They have more salts, largely because of dry climate and poor drainage. They occur in arid and semi arid regions, and in waterlogged and swampy areas. Their structure ranges from sandy to loamy. They lack in nitrogen and calcium. Saline soils are more widespread in western Gujarat, deltas of the eastern coast and in Sunderban areas of West Bengal. In the Rann of Kuchchh, the Southwest Monsoon brings salt particles and deposits there as a crust. Seawater intrusions in the deltas promote the occurrence of saline soils. In the areas of intensive cultivation with excessive use of irrigation, especially in areas of green revolution, the fertile alluvial soils are becoming saline. Excessive irrigation with dry climatic conditions promotes capillary action, which results in the deposition of salt on the top layer of the soil. In such areas, especially in Punjab and Haryana, farmers are advised to add gypsum to solve the problem of salinity in the soil.

Peaty Soils

They are found in the areas of heavy rainfall and high humidity, where there is a good growth of vegetation. Thus, large quantity of dead organic matter accumulates in these areas, and this gives a rich humus and organic content to the soil. Organic matter in these soils may go even up to 40-50 per cent. These soils are normally heavy and black in colour. At many places, they are alkaline also. It occurs widely in the northern part of Bihar, southern part of Uttaranchal and the coastal areas of West Bengal, Orissa and Tamil Nadu.

Forest Soils

As the name suggests, forest soils are formed in the forest areas where sufficient rainfall is available. The soils vary in structure and texture depending on the mountain environment where they are formed. They are loamy and silty on valley sides and coarse-grained in the upper slopes. In the snow-bound areas of the Himalayas, they experience denudation, and are acidic with low humus content. The soils found in the lower valleys are fertile.

Soil Degradation

In a broad sense, soil degradation can be defined as the decline in soil fertility, when the nutritional status declines and depth of the soil goes down the erosion and misuse. Soil degradation is the main factor leading to the depleting soil resource base in India. The degree of soil degradation varies from place to place according to the topography, wind velocity and amount of the rainfall.

Soil Erosion

The destruction of the soil cover is described as soil erosion. The soil forming processes and the erosional processes of running water and wind go on simultaneously. But generally, there is a balance between these two processes. The rate of removal of fine particles from the surface is the same as the rate of addition of particles to the soil layer. Sometimes, such a balance is disturbed by natural or human factors, leading to a greater rate of removal of soil. Human activities too are responsible for soil erosion to a great extent. As the human population increases, the demand on the land also increases. Forest and other natural vegetation is removed for human settlement, for cultivation, for grazing animal and for various other needs.

Wind and water are powerful agents of soil erosion because of their ability to remove soil and transport it. Wind erosion is significant in arid and semi-arid regions. In regions with heavy rainfall and steep slopes, erosion by running water is more significant. Water erosion which is more serious and occurs extensively in different parts of India, takes place mainly in the form of sheet and gully erosion. Sheet erosion takes place on level lands after a heavy shower and the soil removal is not easily noticeable. But it is harmful since it removes the finer and more fertile top soil. Gully erosion is common steep slopes. Gullies deepen with rainfall, cut the agricultural lands into small fragments and make from them unfit for cultivation. A region with a large number of deep gullies or ravines is called a badland topography. Ravines are widespread, in the Chambal basin. Besides this, they are also found in Tamil Nadu and West Bengal. The country is losing about 8,000 hectare of land to ravines every year. What types are prone to gully erosion?

Deforestation is one of the major causes of soil erosion. Plants keep soils bound in locks of roots, and thus, prevent erosion. They also add humus to the soil by shedding leaves and twigs. Forests have been denuded practically in most parts of India but their effect on soil erosion are more in hilly parts of the country.

A fairly large area of arable land in the irrigated zones of India is becoming saline because of over irrigation. The salt lodged in the lower profiles of the soil comes up to the surface and destroys its fertility. Chemical fertilizers in the absence of organic manures are also harmful to the soil. Unless the soil gets enough humus, chemicals harden it and reduce its fertility in the long run. This problem is common in all the command areas of the river valley projects, which were the first beneficiaries of the Green Revolution. According to estimates, about half of the total land of India is under some degree of degradation.

Every year, India loses millions of tones of soil and its nutrients to the agents of its degradation, which adversely affects our national productivity. So, it is imperative to initiate immediate steps to reclaim and conserve soils.

Soil Conservation

Contour bunding, Contour terracing, regulated forestry, controlled grazing, cover cropping, mixed farming and crop rotation are some of the remedial measures which are often adopted to reduce soil erosion.

Efforts should be made to prevent gully erosion and control their formation. Finger gullies can be eliminated by terracing. In bigger gullies, the erosive velocity of water may be reduced by constructing a series of check dams. Specially attention should be made to control headward extension of gullies. This can be done by gully plugging, terracing or by planting cover vegetation.

In arid and semi-arid areas, efforts should be made to protect cultivable lands from encroachment by sand dunes through developing shelter belts of trees and agro-forestry. Lands not suitable for cultivation should be converted into pastures for grazing. Experiments have been made to stabilize sand dunes in western Rajasthan by the Central Arid Zone Research Institute (CAZRI).

The Central Soil Conservation Board, set up by the Government of India, has prepared a number of plans for soil conservation in different parts of the country. These plans are based on the climatic conditions, configuration of land and the social behavior of people. Even these plans are fragmental in nature. Integrated land use planning, therefore, seems to be the best technique for proper soil conservation.

Water Resources

Water is a cyclic resource with abundant supplies on the globe. Approximately, 71 per cent of the earth's surface is covered with it but fresh water constitutes only about 3 per cent of the total water. In fact, a very small proportion of fresh water is effectively available for human use. The availability of fresh water varies over space and time.

Water Resources of India

India accounts for about 2.45 per cent of world's surface areas, 4 per cent of the world's water resources and about 16 per cent of world's population. The total water available from precipitation in the country in a year is about 4,000 cubic km. The availability from surface water and replenish-able groundwater is 1,869 cubic km. Out of this only 60 per cent can be put to beneficial uses. Thus, the total utilizable water resource in the country is only 1,122 cubic km.

Surface Water Resources

There are four major sources of surface water. These are rivers, lakes, ponds, and tanks. In the country, there are about 10,360 rivers and their tributaries longer than 1.6 km each. The mean annual flow in all the river basins in India is estimated to be 1,869 cubic km. However, due to topographical, hydrological and other constraints, only about 690 cubic km (32 per cent) of the available surface water can be utilized. Water flow in a river depends on size of its catchment area or river basin and rainfall within its catchment area.

Given that precipitation is relatively high in the catchment areas of the Ganga, the Brahmaputra and the Barak rivers, these rivers, although account for only about one-third of the total area in the country, have 60 per cent of the total surface water resource. Much of the annual water flow in south Indian rivers like the Godavari, the Krishna, and the Kaveri has been harnessed, but it is yet to be done in the Brahmaputra and the Ganga basins.

Groundwater Resources

The total replenishable groundwater resources in the country are about 432 km. Table shows that the Ganga and the Brahmaputra basins, have about 46 per cent of the total replenishable groundwater resources. The level of groundwater utilization is relatively high in the river basins lying in north-western region and parts of south India.

Basinwise Ground water Potential and Utilization in India (Cubic Km/Year)			
S.No.	Name of Basin Ground water Resources	Total Replenishable Utilization (%)	Level of Groundwater
1.	Brahmani with Baltarni	4.05	8.45
2.	Brahmaputra	26.55	3.37
3.	Chambal Composite	7.19	40.09
4.	Kaveri	12.3	55.33
5.	Ganga	170.99	33.52
6.	Godavari	40.65	19.53
7.	Indus	26.49	77.71
8.	Krishna	26.41	30.39
9.	Kuchchh and Saurashtra Including Luni	11.23	51.14
10.	Chennai and South Tamil Nadu	18.22	57.68
11.	Mahanadi	16.46	6.95
12.	Meghna (Barak & Others)	8.52	3.94
13.	Narmada	10.83	21.74
14.	Northeast Composite	18.84	17.2
15.	Pennar	4.93	36.6
16.	Subarnarekha	1.82	9.57
17.	Tapi	8.27	33.05
18.	Western Ghat	17.69	22.88
	Total	431.42	31.97

The groundwater utilization is very high in the states of Punjab, Haryana, Rajasthan, and Tamil Nadu. However, there are States like Chhatisgarh, Orissa, Kerala, etc., which utilize only a small proportion of their groundwater potentials. States like Gujarat, Uttar Pradesh, Bihar, Tripura and Maharashtra are utilizing their ground water resources at a moderate rate. If the present trend continues, the demands for water would need the supplies. And such situation, will be detrimental to development, and can cause social upheaval and disruptions.

Water Demand and Utilization India has traditionally been an agrarian economy, and about two-third of its population have been dependent on agriculture. Hence, development of irrigation to increase agricultural production has been assigned a very high priority in the Five Year Plans, and multipurpose river valleys projects like the Bhakra-Nangal, Hirakund, Damodar, Valley, Nagarjuna Sagar, Indira Gandhi Canal Project, etc. have been taken up. In fact, India's water demand at present is dominated by irrigational needs.

Agriculture accounts for most the surface and ground water utilization, it accounts for 89 per cent of the surface water and 92 per cent of the groundwater utilization. While the share of industrial sector is limited to 2 per cent of the surface water utilization and 5 per cent of the ground-water, the share of domestic sector is higher (9 per cent) in surface water utilization as compared to groundwater. The share of agricultural sector in total water utilization is much higher than other sectors. However, is future, with development, the shares of industrial and domestic sectors in the country are likely to increase.

Demand of Water for Irrigation

In agriculture, water is mainly used for irrigation. Irrigation is needed because of spatiotemporal variability in rainfall in the country. The large tracts of the country are deficient in rainfall and are drought prone. North-Western India and Deccan plateau constitute such areas. Winter and summer seasons are more or less dry in most part of the country.

Provisions of irrigation makes multiple cropping possible. It has also been found that irrigated lands have higher agricultural productivity than un-irrigated land. Further, the high yielding varieties of crops need regular moisture supply, which is made possible only by a developed irrigation systems. In fact, this is why that green revolution strategy of agriculture development in the country has largely been successful in Punjab, Haryana and western Uttar Pradesh.

In Punjab, Haryana and Western Uttar Pradesh more than 85 per cent of their net sown area is under irrigation. Wheat and rice are grown mainly with the help of irrigation in these states. Of the total net irrigated area 76.1 per cent in Punjab and 51.3 per cent in Haryana are irrigated through wells and tube wells. This shows that these states utilize large proportion of their ground water potential which has resulted in ground water depletion in these states. The share of area irrigated through wells and tube wells is also very high in the states given in table.

The over-use of ground water resources has led to decline in ground water table in these states. In fact, over withdrawals in some states like Rajasthan, and Maharashtra has increased fluoride concentration in ground-water, and this practice has led to increase in concentration of arsenic in parts of West Bengal and Bihar.

Prevention of Water Pollution

Available water resources are degrading rapidly. The major rivers of the country generally retain better water quality in less densely populated upper stretches in hilly areas. In plans, river water is used intensively for irrigation, drinking, domestic and industrial purposes. The drains carrying agricultural (fertilizers and insecticides), domestic (solid and liquid wastes), and industrial effluents join the rivers. The concentration of pollutants in rivers, especially remains very high during the summer season when flow of water is low.

The Central Pollution Control Board (CPCB) in collaboration with State Pollution Control Boards has been monitoring water quality of national aquatic resources at 507 stations. The data obtained from these stations show that organic and bacterial contamination continues to be the main source of pollution in rivers. The Yamuna river is the most polluted river in the country between Delhi and Etawah. Other severely polluted rivers are: the Sabarmati at Ahmedabad, the Gomti at Lucknow, the Kali, the Adyar, the Cooum (entire stretches), the Vaigai at Madurai and the Musi of Hyderabad and the Ganga at Kanpur and Varanasi. Groundwater pollution has occurred due to high concentrations of heavy/toxic metals, fluoride and nitrates at different parts of the country.

The legislative provisions such as the Water (Prevention and Control of Pollution) Act 1974, and Environment Protection Act 1986 have not been implemented effectively. The result is that in 1997, 251 polluting industries were located along the rivers and lakes. The Water Cess Act, 1977, meant to reduce pollution has also made marginal impacts. There is a strong need to generate public awareness about importance of water and impacts of water pollution. The public awareness and action can be very effective in reducing the pollutants from agricultural activities, domestic and industrial discharges.

Watershed Management

Watershed management basically refers to efficient management and conservation of surface and groundwater resources. It involves prevention of runoff and storage and recharge og groundwater through various methods like percolation tanks, recharge wells, etc. However, in broad sense watershed management includes conservation, regeneration and judicious use of all resources-natural (like land, water, plants and animals) and human with in a watershed. Watershed management aims at bringing about balance between natural resources on the one hand and society on the other. The success of watershed development largely depends upon community participation.

The Central and State Governments have initiated many watershed development and management programmes in the country. Some of these are being implemented by nongovernmental organizations also. Haryali is a watershed development project sponsored by the Central Government which aims at enabling the rural population to conserve water for drinking, irrigation, fisheries and afforestation. The Project is being executed by Gram Panchayats with people's participation.

Neeru-Meeru (Water and You) programme (in Andhra Pradesh) and Arvary Pani Sansad (in Alwar, Rajasthan) have taken up constructions of various water harvesting structures such as percolation tanks, dug out ponds (Johad), check dams, etc. through people's participation. Tamil Nadu has made water harvesting structures in the houses compulsory. No building can be constructed without making structures for water harvesting.

Watershed development projects in some areas have been successful in rejuvenating environment and economy. However, are only a few success stories? In majority of cases, the programme is still in its nascent stage. There is a need to generate awareness regarding benefits of watershed development and management among people in the country, and through this integrated water resource management approach water availability can be ensured on sustainable basis.

Rainwater Harvesting

Rain water harvesting is a method to capture and store rainwater for various uses. It is also used to recharge groundwater aquifers. It is a low cost and eco-friendly technique for preserving every drop of water by guiding the rain water to bore well, pits and wells. Rainwater harvesting increases water availability, checks the declining ground water table, improves the quality of groundwater through dilution of contaminants like fluoride and nitrates, prevents soil erosion, and flooding and arrests salt water intrusion in coastal areas if used to recharge aquifers.

Rainwater harvesting has been practiced through various methods by different communities in the country for a long time. Traditional rain water harvesting in rural areas is done by using surface storage bodies like lakes, ponds, irrigation tanks, etc. In Rajasthan, rainwater harvesting structures locally known as Kund or Tanka (a covered underground tank) are constructed near or in the house or village to store harvested rainwater.

There is a wide scope to use rainwater harvesting technique to conserve water resource. It can be done by harvesting rainwater on rooftops and open spaces. Harvesting rainwater also decreases the community dependence on groundwater for domestic use. Besides bridging the demand supply gap, it can also save energy to pump groundwater as recharge leads to rise in groundwater. These days rainwater harvesting is being taken up on massive scale in many states in the country. Urban areas can specially benefit from rainwater harvesting as water demand has already outstripped supply in most of the cities and towns.

Apart from the above mentioned factors, the issue desalinization of water particularly in coastal areas and brackish water in arid and semi-arid areas, transfer of water from water surplus areas to water deficit areas through inter linking of rivers can be important remedies for solving water problem in India (read more about inter linking of rivers). However, the most important issue from the point of view of individual users, household and communities is pricing of water.

Highlights of India's National Water Policy, 2002

The National Water Policy 2002 stipulates water allocation priorities broadly in the following order: drinking water; irrigation, hydro-power, navigation, industrial and other uses. The policy stipulates progressive new approaches to water management. Key features include:

- Irrigation and multi-purpose projects should invariably include drinking water component, wherever there is no alternative source of drinking water.
- Providing drinking water to all human beings and animals should be the first priority.

- Measures should be taken to limit and regulate the exploitation of groundwater.
- Both surface and groundwater should be regularly monitored for quality. A phased programme should be undertaken for improving water quality.
- The efficiency of utilization in all the diverse uses of water should be improved.
- Awareness of water as a scarce resource should be fostered.
- Conservation consciousness should be promoted through education, regulation, incentives and disincentives.