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ENVIRONMENTAL CHEMISTRY

CHAPTER – 4

LAND POLLUTION

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Ch:4 LAND POLLUTION KHURRAM SHAHZAD

SOIL:- DEFINITION

"Soil is a dynamic natural body on the surface of the earth in which plants grow, and is composed of minerals, organic materials and living forms." OR

Soil is uppermost weathered layer of the soil's earth crust. It consists of rocks that have been reduced to small fragments & have been more or less changed chemically together with the remains of the plants and animals that live on it and in it.

✱ IMPORTANCE OF SOIL

Soil is a valuable natural resource, which gives us food, clothing and shelter. We pollute it & abuse it; but even we could not survive without it.

It is one of the most significant ecological factors, which is derived from the transformation of surface rocks, plants depends on it for their nutrients, water & mineral supply. It constitutes an important medium where animal live. The importance of soil may be realised from the following statement

"The eternal truth that soil and water

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are the two significant capitals of mankind and the natural forest are the mothers of rivers and the factories for manufacturing soil. The soil provides home and ideal environmental conditions for living beings."

(1) SOILS AND AGRICULTURE:-

The most important use of soil is to grow the world's (1) food and fibre.

→ If we want food, to just keep us alive is about 180 kg of grains per person per year. About 0.2 acres is needed to grow that amount of grain.

→ We need soil to grow crops for (2) fibres (e.g. cotton) or (3) fuel by converting the grain ethanol Fuel substitute will become more important as our oil resources become used up.

(2) SOILS AND SHELTER:-

Another use of soil is provide shelter. Many early settlers built such houses that survive for many years. Animals also use shelters for their survival.

(3) SOILS AND CONSTRUCTION:-

Soil is support medium for roadwa

bridges and buildings.

④ **SOILS AND WATER:-**

Soil acts as a water sesevior. With out soil plant cannot grow. Irrigation is essential in many parts of the world for economic crop production.

⑤ **NATURAL FILTER:-**

Soil acts as a physical, chemical and biological filter which removes harmful organisms and pollutants from our ground water municipal waste, pesticides and other chemical and recycles waste.

⑥ **GLOBAL CYCLES:-**

Soils are key link in global, Carbon hydrogen, Nitrogen, sulphur and phosphorus the cycles etc. These cycles involve soil chemical processes some of the processes include decomposition of organic matter, nutrification, denitrification, phosphorus fixation, sulphide oxidation etc

★ **NATURE AND COMPOSITION OF SOIL:**

SPONGE:-

The soil is like a big sponge; having numerous tiny pores. Some pores are so tiny that even bacteria can not enter. Other pores may be until they are blocked by an organic matter.

particle or a small aggregate.
⇒ Some cores will be water logged; others dry.

CHEMICAL FACTORY:-

The soil is a chemical factory producing thousands of different organic chemicals as a result of the action of living organisms. It contains enzymes, sugars, starch, proteins, D.N.A & so on.

SOIL; A THREE PHASE SYSTEM

Soil is made up of three phases.
⇒ Solids ⇒ Liquids ⇒ Gases
Each phase is necessary for the life & growth of plants.

⇒ **SOLID** ⇒ Solid may be living or non living. The (non living) part of the solid is mineral inorganic material while (living) is organic matter.

LIQUID ⇒ The liquid part is water.

GAS ⇒ The gas part is soil air.

MAJOR COMPONENTS

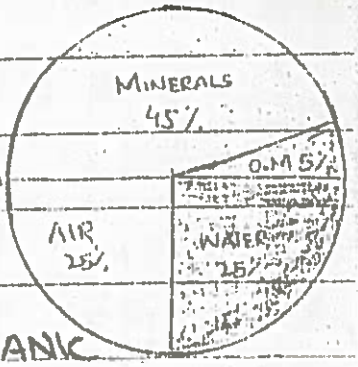
The soil consists of four major components. viz ① MINERAL MATTER ② ORGANIC MATTER ③ SOIL AIR ④ SOIL WATER
All these components are mixed intima-

tely with each other that they cannot be separated completely

VOLUMETRIC COMPOSITION:-

The volumetric composition of mineral soil i

1. Mineral matter 45% } SOLID
2. Organic matter 5% } SOLID
3. Soil water 25%] LIQUID
4. Soil air 25%] Gas



① MINERAL MATTER OR INORGANIC SUBSTANCES

Mineral particles are formed from rock by physical and chemical weathering processes. The size and grouping of various particles effect the characteristics of the soil such as texture.

(a) Primary Minerals:-

Primary minerals come directly from rock such as quartz, feldspar and micas etc.

(b) Secondary Minerals:-

Secondary minerals are formed from primary particles by weathering. EXAMPLE:- CLAY, SILICA

The chief inorganic constituent of soil are the compounds of Ca, Al, Mg, Fe, Si, K, Na

Small amounts of the compounds of Mn, Cu, Zn, Co, Bo, I, Fe etc are also present

in the soil.

⇒ Soil solution also contains complex mixtures of minerals as carbonates, sulphates, chlorides nitrates and also organic salts of Ca, Mg, K, Na

⇒ The elements are geochemically distributed and on the basis of their bonding characteristics they have been classified into five main groups.

a) LITHOPHILE ELEMENTS:-

⇒ These elements which are readily ionised forming oxyanions. EXAMPLE:- O, Si, Ti, Fe, Mn etc. & rare earth metals.

(b) CHALCOPHILE ELEMENTS:-

These elements which tends to find covalent bonds with sulphide. EXAMPLE S, Se, Te Fe, Ni, Co, Cu, Zn etc.

(c) SIDEROPHILE ELEMENTS:-

These elements which are capable of forming metallic bonds readily EXAMPLE Fe, Co, Pt, Au, Os.

(d) ATMOSPHILE ELEMENTS:-

These elements which tends to remain in atmospheric gases. EXAMPLE N, O, H, Ne, Ar, Kr, Xe.

(e) BIOPHILE ELEMENTS:-

Those elements which tends to be associated with living organisms EXAMPLE C, H, O, N, P, S, Cl, I, Mg, Na, K etc.

ORGANIC SUBSTANCES:- HUMUS

The chief organic component of the soil is humus which contains a large number of organic compounds such as amino acids, proteins, aromatic compounds sugars, alcohol, fats, oil, waxes etc. As a result humus is black coloured, homogenous complex material. Humus is derived from the decomposition of organic matter.

DEAD PART:-

About 50% of the organic matter is composed of dead remains of the soil life in all stages of Decomposition.

ALIVE PART:-

The remaining 50% portion of the organic matter is alive & consists of plant roots, bacteria earth worms, algae, fungi, Nematodes, rodents insects etc.

CHARACTERISTICS OF ORGANIC MATTER:-

The most important characteristics of the organic matter in soil are follows

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1. It improves the physical condition of soil.
2. It increases the water holding capacity of soil.
3. It is major source of nutrient i.e N, P, Sulphur
4. Main source of energy for soil organisms.
5. It reduces (Humus) the pore size & reduces the clumps of soil.
6. It reduces the soil erosion, shades the soil and keeps the soil cooler in extreme hot weather and warmer in winter.

SOIL WATER

- Water is in liquid or gaseous form, & may occupy pore spaces not occupied by gases.
1. Water acts as a medium where nutrients from the minerals and decaying organic matter are released and made available to plants roots. Water is also an effective temperature regulator of soil, giving the living organisms a more stable environment to grow & reproduce
2.

SOIL SOLUTION:-

The water dissolves salts and make soil solution. The soil soln is important as a medium for supplying different essential nutrients b/w the soil solids & the soil solution & then b/w the soil soln & the plants.

SOIL MOISTURE:-

Water contained in the soil is called soil moisture. The two basic forces for water retention in soil are cohesive & Adhesive forces.

COHESIVE FORCES:-

The forces of attraction present b/w the molecules of water are called cohesive forces.

ADHESIVE FORCES:-

The forces of attraction b/w the water molecule and solid surface are called adhesive forces.

FUNCTION OF WATER

There are four important function of water in plant growth.

(1) It is the major constituent of plant protoplasm (85-95% water)

(2) It is essential for photosynthesis and conversion of starches to sugars.

(3) Soil solution is important as a medium for supply of nutrients to growing plants.

(4) It provides plant turbidity, which maintains the proper form and position of plant parts to capture sunlight.

The soil water is great regulator of physical, chemical and biological activities in the soil. Plants absorb some water through leaf stomata but most of the water used by plants is absorbed by the roots from the soil.

The soil water may be

(i) Gravitational water
(ii) Capillary water
(iii) Hygroscopic water

GRAVITATIONAL WATER:-

"Gravitational water is the free water which moves down into the soil because of gravity till it reaches water table."
It has low energy of retention, not used by plants

CAPILLARY WATER:-

Capillary water is the water which is present in the capillary interspaces of the soil particles. It has greater retension value, so it is of great value to plant life.

HYGROSCOPIC WATER:-

Hygroscopic water is the water which forms a thin film on the soil particles. It is not available to plants

Soil Air

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Air spaces are found inbetween the soil particles, hold air which constitute gaseous system of the soil. Gases occupy these spaces. Most commonly found gases in soil includes N_2, O_2 & CO_2. The earth atmosphere is composed of mainly 78% N_2, 21% O_2 & 0.1% CO_2. The respiration of plants roots and microbes generally increase the level of O_2 & CO_2 in atmosphere.

Soil gases are essential to the life cycles of soil animal organisms and plants.

⇒ Soil Aeration:-

The exchange of CO_2 and O_2 gases b/w the soil pore space and the aerial atmosphere is called soil aeration.

⇒ A well aerated soil is that which contains sufficient amount of gases available to growing aerobic organisms.

Oxygen :-

⇒ Soil air is necessary for plant growth as oxygen present in the air breaks down insoluble soil minerals into soluble salts which are used by plants. (1)

It is also necessary for the respiration of soil micro organisms by whose activity soil fertility is increased. (2)

Poor Soil Aeration:-

poor soil aeration results in accumulation of CO_2 which causes formation of H_2S, formic acid, acetic acid, oxalic acid & other toxic acids. Because of these toxic acids soil organisms (both micro & macro-organisms) are killed.

2) Excess of CO_2 is also responsible for decrease in PH of the soil which prevents nutrients from reaching into the plant.

Characteristics Of Soil Air

- Due to poor aeration

1) ⇒ development of plants roots is restricted
2) ⇒ Absorption of water and nutrients decreased
3) ⇒ Toxic substances are formed
4) ⇒ Produce different types of diseases.
5) ⇒ Rate of organic matter decomposition decreases due to decreased microbial activity under reduced O_2 contents

* Macro & Micro Nutrients In Soil

Plant Nutrients:-

"The food of plant is composed of certain chemical elements, known as plant nutrients" Green plants are autotrophic so they prepare their food & hence nourish themselves. About 35 elements have been regarded for

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Nutrition for plants.

ESSENTIAL ELEMENTS:-

Out of these about Seventeen (16) elements are required by the plants to grow & to reproduce. Essential elements are divided into (2) Micronutrients & Macronutrients.

NATURAL NUTRIENTS:-

The nutrients that are derived from air and water are called natural nutrients, these are three, namely C, H & Oxygen.

The remaining elements are provided by the soil.

SOIL FERTILITY:-

The study of the ability of the soil to supply and sustain adequate (supply) amounts of nutrients for plant growth is called soil fertility.

MACRONUTRIENTS:-

These are the nutrients that are required by plants in relatively large amounts. Three of them are supplied by the air & water ie, CARBON, HYDROGEN, OXYGEN & Six supplied by the soil

→ Nitrogen	N	phosphorus	P
Potassium	K	Calcium	Ca
Magnesium	Mg	Sulphur	S

زندگی کی مستی میں سوئی نشہ لگا کر آئی
Fe Ni B Cu Mn, Mo, Cl Zn

MICRONUTRIENTS:- Fe, Cu, Ni, Mn, Cl, B, Zn, Mo

"The elements required by the plants in relatively small amounts are called micronutrients." These are seven; including

- ⇒ Chlorine Cl — Iron Fe
- → Boron B — Manganese Mn
- → Zinc Zn — Copper Cu
- → Molybdenum Mo — Nickel Ni

NUTRIENT FUNCTIONS:-

The role of various nutrients in the plant growth have been studied extensively but is not yet fully understood, some of the important findings are briefly given below.

MACRONUTRIENTS:-

→ **NITROGEN:-** Nitrogen is key element for protein formation. It is the most important nutrient for the plant. Nitrogen is valueable for growth and for proper body functioning.

PROTEIN FORMATION:-

Roots of the plants takes up Nitrogen mainly in the form of ammonium (Cationic form NH_4) or Nitrate (anionic form NO_3) ions and forms amino acids. These aminoacids are then converted into proteins and enzymes. Protein makes the part of protoplasm, while enzymes acts as a catalysts for various reactions taking

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place in the plants.

=> It is also an important part of chlorophyll without which photosynthesis is not possible.

SOURCES:-

The main sources of nitrogen are

(a) Fertilizers (b) Atmosphere

(c) Organic nitrogen compounds formed in the soil by decaying natural processes.

=> Air contains 78% of N, but it cannot be used directly except the plants belonging to the Leguminous Family. They have Nitrogen fixing bacteria called RHIZOBIUM. Nitrosomonas in their soils

FUNCTIONS OF NITROGEN:-

1) It encourages the above ground vegetation to grow well & give dark green colour to plants.

2) It gives high yields.

3) It increases the protein contents of food & fodder.

4) It regulates the utilization of K, P & other constituents.

ABUNDANT SUPPLY:- In excess of N then

(i) => It delays ripening.

(ii) => It delays reproductive growth. formation

(iii) => Deteriorates the quality of some crops eg potato.

(iv) Plants become more susceptible to disease.

(v) Leaves become thick, leathery & sometimes crinkled.

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DEFICIENT SUPPLY:-

The deficiency of nitrogen may cause Chlorosis

→ The plant becomes yellowish or light green

→ The leaves and young fruits tend to drop prematurely

→ Crop give poor yield

→ The seeds becomes small in size & light in weight ⑤ Root growth is severely affected.

LOSES:- The nitrogen loss takes place by

1) **Crop Removal:-** When crop is harvested it takes some of nitrogen from soil. EXAMPLE

→ A 2000 kg/hector crop of canola will removes as much as 70 kg of N/ha from the soil & go to seeds in the seed.

2) **BURNING STRAW:-**

Burning of straw also lose N.

If we burn the straw from our 2000 kg/ha wheat crop, we will lose 15 kg N/ha to the atmosphere.

3) **VOLATILIZATION:-** Fertilizers such as ammonia or urea can be lost when unfavourable soil conditions exist. EXAMPLE If urea is applied to the soil surface with trash covers and the soil is dry, up to 40% can be lost before rain of the urea is washed into the soil.

④ Denitrification:- (17)

Under water logged conditions in the presence of organic matter, soil micro-organisms can convert soil nitrate to nitrogen gases such as N_2, N_2O and NO which are lost to atmosphere.

⑤ LEACHING:-

Urea fertilizers and soil nitrates are very mobile in soil solution and can be washed down the soil profile by heavy rainfall precipitation. Much of this nitrogen finds its way into aquifers, streams and lakes contaminating the water ways and drinking water.

ADDITIONS:-

Nitrogen is added to the soil by

1) NON SYMBIOTIC N- FIXATION:-

Non symbiotic Nitrogen fixation by lightning and free living soil organisms.

2) SYMBIOTIC FIXATION:-

Symbiotic fixation by legumes, because they have nitrogen fixing bacteria called Rhizobium. Alfafa fixes largest amounts but sed clover the least.

3) FERTILIZERS:-

Deficiencies in nitrogen have to made up for by the addition of natural or chemical fertilizers.

PHOSPHORUS:- "P"

⇒ Phosphorus is essential constituent of every living cell and for the nutrition of plant and animal.

1) It is structural component of the membrane & cellwall system of cells, the chloroplast and the mitochondria.

2) It is a constituent of nucleic acid, e also found in seeds and fruits. (DNA & RNA)

FUNCTION OF PHOSPHORUS

1. The main function of phosphorus includes.

(a) It stimulates the root development & growth in seedling.

(b) It enhances leaf development and encourages greater growth of shoots and roots.

(c) It enhances the development of reproductive part.

(d) It increases the yield.

(e) It influences cell division and formation of fat and albumin.

(f) It helps in fixing more atmospheric nitrogen in root nodules.

EXCESSIVE PHOSPHORUS:-

Excessive phosphorus has following adverse effects.

(a) Profuse root growth.

(b) It may cause trace metal deficiencies.

(c) It develops normal growth having green leaf colour.

(d) Unlike nitrogen excess of phosphorus is not harmful.

DEFICIENCY OF PHOSPHORUS (19)

(a) Root and shoot growth is restricted.
(b) Leaves may shed prematurely
(c) The leaves may become dull greyish green.
(d) Stunted growth and premature ripening of crop
(e) Delaying in flowering and fruiting.

POTASSIUM:- "K"

Most potassium is found in plants in the above ground portion of cereal and oil seeds mainly in the straw. There, if crop residues are returned to the soil, a good proportion of the potassium is conserved.

The function of potassium is not clearly found but it has been known that it is essential for healthy growth of plants.

FUNCTION OF POTASSIUM:-

(a) It is essential element for the growth of chlorophyll.
(b) It is essential for photosynthesis.
(c) It is necessary for tubes development.
(d) It increases the crop resistance to certain diseases.
(e) It is necessary for the best production of grains and fruits.
(f) It acts as an enzyme activator.

DEFICIENCY OF POTASSIUM:-

Chlorosis:- Deficiency of K may cause Chlorosis and stunted

Mg act as a carrier of Phosphate. Also it is a mineral constituent of chlorophyll (2.7% by wt)
Ca is found as a constituent of cell walls of leaves. It is closely associated with growth of flowers.
i.e yellowing of leaves.
(b) Deficiency causes dying back tips of shoots.
(c) Decrease rate of photosynthesis.
(d) Plant became stunted in growth & bushy in appearance.
(e) It causes blackening of tubers. black lesions

SULPHUR :- 'S'

The plants grow best on sulphur rich soil. The sulphur needs of plants are small and supplied by soil compounds.

FUNCTION OF SULPHUR :-

Protein Synthesis :-

Sulphur exists in two important amino acids methionine and cystine, which are also component of protein. Plants such as mustard, Canola produce a large number of protein in their tissues & seeds.
→ It is involved in the formation of chlorophyll.
→ It encourages vegetative growth. It is necessary for synthesis of oils in brassica
→ Pungent odours of onion and garlic is because of presence of sulphur compounds. & for enzyme actions & plant growth
→ It helps in increasing root growth.
→ It promotes nodule formation

DEFICIENCY OF SULPHUR :-

Its deficiency may cause following adverse effects.

(a) Young leaves may turn yellow.
(b) Nodulation in legumes may be poor and fixation of nitrogen is reduced.
(c) The fruits become light green & less juicy.
(d) Maturity in cereals may be delayed.
(e) Less production of protein and oil.

MICRONUTRIENTS:-

"The elements required by the plants in relatively small amounts are called micro-nutrients" These are
⇒ Chlorine, IRON, Boron, ZINC, Manganese, Copper, Nickel & Mo.
⇒ Even though they are required in much smaller amounts, but they are as important as macronutrients to the survival and growth of plants.

MICRONUTRIENTS IN SOIL:-

The availability of micro-nutrients is largely determined by three variables
(1) ⇒ The abundance of parent mineral present
(2) ⇒ The chemical conditions in soil, e.g PH
(3) ⇒ The rate of movement of available forms in the soil media.

⇒ Many micronutrients are almost immobile in soil or react to form complexes with organic matter and clays to form immobile compounds. This type of behavior is fortunate since

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the micro-nutrients are then protected from being lost due to leaching.

Multiple cropping with high yielding varieties of crops is one of the most important reasons of removal of micro nutrients from the soil.

FUNCTIONS OF MICRONUTRIENTS:-

(a) They help in photosynthesis of green plants & also synthesis of chlorophyll.

(b) They act as a catalyst for oxidation, reduction reactions within the plant.

(c) They are responsible for regulating activity of various enzymes.

(d) Some are essential for synthesis of vitamin A.

(e) They help in normal growth & absorption of Nitrogen from the soil.

(f) They are responsible for biosynthesis of plant growth hormone and in the reproduction process.

(g) They help in protein synthesis in chloroplast.

(h) They enhance symbiotic nitrogen fixation.

DEFICIENCY OF MICRONUTRIENTS:-

1 ⇒ The growth of the plant is hampered.

2 ⇒ The plants are subjected to attack by diseases.

3 ⇒ Yield of crop decreases accordingly.

4 ⇒ Shedding of flowers, improper fertilization etc.

CORRECTING MICRONUTRIENT DEFICIENY (23)

Most micronutrients are absorbed as ions through the plant root system.

MICRONUTRIENT	PLANT AVAILABLE FORM
Copper	Cu^{+1}
Zinc	Zn^{+1}
Iron	Fe^{+1}
Boron	$H_2BO_3^-$
Molybdenum	MoO_4^-

→ Plants can also absorb sufficient amounts through leaves. Fruits and some vegetables can often be sprayed by (micronutrient chelates)

→ Appropriate methods should be adopted for applying micronutrients which depends on

⇒ Soil chemical reactions

⇒ Its toxicity.

Micronutrient	COMMON FERT. FORM	Application Method
Zn	$ZnSO_4$	Can be foliar applied
Copper	$CuSO_4$	Soil application is effecti
Manganese	$MnSO_4$	Soil & some cases foliar aff. is effe
Molybdenum	Sodium & Ammonium Molybdate	Soil appl. is uncommon, used coating in legumes foliar rare but effective
Boron	All inorganic sources e.g. H_3BO_3	foliar aff. on perennial cr
IRON	Animal manure	foliar app. & seed coating
	Ferrous sulphate chelated IRON	both are effective

Def:- The detachment & transportation of the soil.

→ Running H2O, wind, waves of sea, & moving ice etc cause a certain amount of erosion called GEOLOGICAL EROSION, which is a natural process going on very slowly.

SOIL ERROSION:-

DEFINIT. It is that physical process by which soil material is weathered away and carried down by water or moved about by wind.

when water or wind moved across the surface of land, it picks up soil particles & carries them away in suspension.

NORMAL EROSION:-

Under natural conditions, dense vegetation slows down this movement of soil to such a speed that new soil is formed from the parent material below (subsoil) as rapidly as upper soil layer (top soil) is removed away. Such a normal and natural removal of top soil is known as (normal erosion, natural erosion).

Soil erosion is the single most destructive phenomenon in the world. The small soil particles find their way into streams, rivers and lakes. Here the fine particles (1) clog the water ways. (2) Sunlight is absorbed by the particles which raise the temperature of the water, so changing the entire ecosystem.

(3) Pesticides pollutants & excess nutrients are also carried along with the particles contaminating every part of our environment.

through ages is a both constructive & destructive

CAUSES OF SOIL EROSION → These are ① Heavy destruction of the protective cover like trees & grass by indiscriminate cutting down of trees, forest fires, overgrazing & burning of grassland. (on 28 Page) 25

LOSES CAUSED BY SOIL EROSION:-

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① ⇒ wastage of centuries of nature's work.

② ⇒ Loss of plant nutrient.

③ ⇒ Loss of soil

④ ⇒ Filling of streams channels, Irrigation channels which destroy crops and towns every year.

⑤ ⇒ This causes Flood.

⑥ ⇒ It has also caused formation of deserts & dust bowls.

TYPES OF SOIL EROSION:-

The soil may be eroded by water or air.

① WATER EROSION:-

It is the movement of soil by ~~rain~~ dumping water, including melted snow, running rapidly over exposed land surface. Rate of water erosion depends upon the factors such as 1) slope 2) Nature of soil 3) vegetation cover & 4) intensity of rainfall. Soil erosion increases by

CAUSES ⇒ 1) wrong farm practices, 2) over grazing, 3) burning & 4) activity of rodents.

TYPES OF WATER EROSION:-

There are four main types of erosion by water.

1. Sheet Erosion:-

It is the removal of soil in thin

5) Stream bank erosion :- banks of the stream & rivers are eroded by flowing H_2O.

6) Sea or Shore erosion :- tidal waves of sea also cause erosion

layers or sheet. It usually occuries in ploughed fields that have been recently prepared for seeding, but may also takes place when crop is seeded. Generally finer particles are removed.

⇒ The dark colour top soil is removed & light colour subsoil is exposed.

⇒ Sheet erosion is often a slow process.

2. Rill Erosion:-

During heavy rains, runoff water is accumulated in small streams. As velocity of water increases it cuts narrow trenches or rills. The rills are like furrows.

This type of erosion is more visible than sheet erosion. It remove large quantities of soil & reduce the soil fertility rapidly.

3. Gully Erosion:-

In this type of erosion, the concentrated run off water is large enough to cut deep trenches or gullies. These gullies go on deepening due to continuous cutting. They also develop in the deep impressions of the wheels of farm machinery.

⇒ There are two types of gullies

V-shaped ⇒ Narrow V shaped bottom

U-shaped ⇒ Broad bottom.

Slip erosion:- Caused by [illegible] penetrating into soils, causing the heavy soil.

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(4) SPLASH EROSION:-

When rain falls on the unprotected, uncovered soil the large rain drops strike the soil with considerable force & disturb the immediate surface of the soil soil.

EFFECTS OF WATER EROSION:-

Erosion by water has many effects which varies from place to place depending on kind of land some effects are described as.

(1) Difficulty in farming operation.
(2) Exposure of subsoil.
(3) Reduction of yield
(4) Erosion deposits on agricultural land.
(5) Deposits in reservoirs, waterways & harbours. بندرگاہ
(6) Floods
(7) Lowering of water supply
(8) Damage highways & railways.

CONTROL MEASURES FOR WATER EROSION:-

1:- Increase the organic matter content of the soil to improve structure and water holding.
(2) Use fertilizers to increase soil productivity
3:- By providing vegetation cover.

The following methods are used for controlling erosion

(1) CROP ROTATION:-

It is defined as alternative growing of

1) Malpractices :- in the use of land such as
i) up& successive growing of crops which accelerate soil erosion
ii) removal of org matter & other valuable plant nutrients

crops on a given area, in recurring succession.
The crops used are
(i) Cultivated crop (cotton maize, tobacco etc.)
(ii) Small grain crop (wheat, barely, oat,)
(iii) Biennial or perennial legume.

② STRIP CROPPING:-
Strip cropping is a system of ~~cropping~~ farming in which ordinary farm crops are planted in relatively narrow strips across the slope of the land.

③ Protective Cover Cropping:-
Soil is covered with vegetation throughout the year. It will be less exposed to erosion. Various summer cover crops may be left on ground through winter, even though dead, thus providing good protection.

④ CONTOURING.
It is defined as any tillage practice or mechanical treatment of land applied across the slope of the level or on the counter i.e. line on the ground, all parts of which are at the same height from the sea level.

⑤ TERRACING :- It involves the formation of channel, with a ridge below.

by burning & injudicious (unwise) cropping practices
(iii) Faulty methods of irrigation.

(2) WIND EROSION:-

Wind erosion often occures in the localities where water erosion is also active.

(1) ⇒ Soil washing (water erosion) depends both on slope and rainfall, while soil erosion by wind is an acute problem on both level and sloping areas during dry seasons.

(2) ⇒ Wind erosion proceeds slowly when soil is stable and covered with normal vegetation.

(3) ⇒ Wind erosion is very active in relatively flat areas, especially if it is without vegetation.

(4) ⇒ The ploughed fields are more susceptible to erosion because they are devoid of grass roots and organic matter.

(5) ⇒ Sandy soil are more subject to erosion by wind than silt loam and clay loam soils.

(6) ⇒ Wind erosion form deposits on vegetation to cause great damage to it.

(7) ⇒ Sometimes sea ports are filled with sand & a lot of money is spent for removing the deposited sand.

CONTROL OF WIND EROSION:-

The following measures are adopted to check erosion by wind

① WIND BREAKS OR SHELTER BELTS:-

Under conditions of low rainfalls, a number of hardy trees and shrubs are planted against the direction of the wind. These plantations reduce the velocity of the wind, thus causing reduction in rate of erosion.

② MAITENANCE OF VEGETATION COVER

The roots of grasses and shrubs bind up the soil particles so that the soil can not be easily removed by the fast moving wind.

③ CULTIVATION OF SOIL:-

If wind erosion begins on a bare field or where a crop is just starting, the soil drifting may be stopped temporarily by cultivation.

④ MULCH FARMING:-

The crop residue or mulch is retained on the land b/w two crops which though dead, gives a protective cover to the soil against erosion.

⑤ IRRIGATION DURING WIND STORM SEASON:-

The soil is especially kept moist by irrigation during the season of wind storms. The wet soil is less susceptible to erosion by wind.

⑥ CONTOUR PLOUGHING AND STRIP CROPPING:

Ploughing the soil on the contour lines at the high angles to slopes is an effective means

of checking erosion by wind.

(Strip cropping) i.e. Growing crops alternatively with fallow, untilled land in the form of strips also protects the soil against wind erosion.

* PH OF SOIL

"PH is the measure of the hydrogen ion activity within the soil"

A soil may be regarded as neutral acidic or alkaline if its PH value is seven, below seven and above seven respectively. A PH scale ranges from strongly acidic to strongly basic (PH 0 → 14)

→ Most soils are within a PH range from (4.5 → 8.5)

→ The best growth for greatest variety of plants takes place within a 6.0 → 7.0 range.

ACIDIC SOILS :-

"The soil derived from the (granite rock) is called acidic soil having the PH 5 → 6.5." Such soils are generally found deficient in Ca^{++} & Mg^{++} They are injurious to earthworms.

ALKALINE SOIL :-

The alkaline soils (PH 7.5 → 8) are derived from (limestone rocks) These soils are formed by excessive evaporation of water in dry areas which brings salts to the surface.

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(1) ⇒ Some organisms are found at extremes of PH. For example, Euglena thrive in water that drains out of mine and has a PH of (1.8).
⇒ Many bacterial and fungi are found to thrive at PH 1.4.

(2) ⇒ Soils which are higher in acidity or alkalinity levels can results in deficiencies or excess of certain kind of elements.
⇒ Higher alkalinity can make elements such as Fe^{+} Mn & Zn less soluble and therefore less available for plant absorption.

(3) ⇒ Defficiencies of these elements can cause poor growth or poor health.
⇒ Higher acidity can cause higher % age of certain substances that are absorbed in soln. by plant.

EFFECT ON MICRO-ORGANISMS

The pH of soil can affect the activities of micro-organisms, which then effects the level of nitrogen, Phosphorus and sulphur in the soil. Most organisms prefer a near-neutral range. Outside this range the numbers of micro-organisms and the rates of their biochemical activities decrease.

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ACIDIFICATION

Def: "Soil acidity may be defined as "the soil system proton (H^+ ions) donating capacity during its transition from a given state to a reference state."

In acid soils, most of the plant nutrient become unavailable and as a result plant growth is affected.

SOURCES OF ACIDIFICATION

1 (a) Leaching due to heavy rain fall.
2 (b) Microbiological actions.
3 (c) Acidic parent material.
4 (d) Continuous use of acid forming fertilizers.
5 (e) Removal of bases of crops.
6 (f) Humus and other organic acids.
7 (g) Aluminosilicate minerals.
8 (h) CO_2 & Acid rain (if Hydraus oxide
9 (i) Aluminum and iron polymer

★ ION EXCHANGE:- OR ION MOVEMENT:-

1) => Soil have million of pores of all sizes and shapes many of which are blocked by organic matter and mineral particles.

2) => Soil is a constantly changing system that have numerous barries to the movement of organisms and chemicals

3) => For a nutrient to be available for plant to

take up it must be the in the (a) proper chemical form to pass the root membrane and (b) most importantly it must be available at the root surface.

CONCENTRATION:-

The movement of nutrients in soil is dependent on their (1) conc. in soil soln, (2) how strongly they are absorbed by the clays & organic matter, and (3) how fast they can move.

Example: Phosphorus is present in soil soln as orthophosphate ($H_2PO_4^-$ or HPO_4^{-2}) in very low conc. & is strongly absorbed by the soil surface. In contrast nitrogen is present in greater conc. in soil soln. (usually as NO_3^-) and is very weakly absorbed.

Nutrients move through the soil to plant roots in three ways.

* Root interception
* Mass flow
* Diffusion

(1) ROOT INTERCERTION:-

⇒ It is the root that moves to the nutrients. The roots of the plants are constantly expanding which open up blocked pores & grow from area of depleted nutrients to the

other regions where the nutrients more concentrated These nutrients are perhaps (1) held on soil surfaces or in (2) packed in fertilizer pellet

The root interception system is very valuable because root growth can extend to areas where mass flow & diffusion take over.

(2) MASS FLOW:- move with water.

Growing plants are continually absorbing water from the soil profile. Dissolved in this water (soluble) nutrients These nutrients are thus transported along with the water to the root surface. Nutrients which are strongly adsorbed to the soil surfaces like phespherous would never get there. But nitrogen which is held very weekly by soils readily moves along with water. Nutrients that move by mass flow are those which have a high concentration in soil soln. relative to the plant requirements eg. Nitrate & sulphate

(3) DIFFUSION:-

Defn- The random movement of ions in response to thermal energy is called diffusion.

If a piece of fertilizer is placed into soil it will slowly dissolve and the solution will spread out slowly and mix with the soil solution Phesphorus will rarely move more than a few millimeter from a

fertilizer granule in a whole growing season. Diffu-sion is dominant mechanism of movement for phosp-horus and most of the micro-nutrients.

CATION EXCHANGE:-

An example of chemical properties in soil is the way in which positively and negatively charg-ged particles (ions) within the soil react to one another.

⇒ The colloidal mineral and organic matter parti-cles in soils usually have a net negative charge.

⇒ The clay fraction of soil is composed of layer silicates have more negative charge or cation exch-ange capacity than (sands) which are composed largely of neutrally charged inert minerals such as quartz.

⇒ Many natural soil nutrients and those from applied fertilizers have positive ions (cations) e.g. K^+, Ca^{2+}, Mg^{2+} These nutrients are attracted to & held by the soil particles so balancing the charge. This is important to soil fertility as some nutrients remain available in the soil & are not leached readily.

In humid regions basic cations on the surface such as Ca^{++} are gradually replaced by acidic cations like H_3O^+, $Al(OH)^{++}$, $Al(OH)_2^+$

ION EXCHANGE IN SOILS

Dissolved mineral matter in soil is largely present as ions. Prominent among the (cations) are H^+, Na^+, Mg^{+2}, K^+, Ca^{+2} & usually very low levels of Fe^{+2}, Mn^{+2} & Al^{+3}. (ANIONS) that may be present are HCO_3^-, CO_3^{-2}, HSO_4^-, SO_4^{-2}, Cl^- & F^-.

One of the most important chemical functions of soils is the "EXCHANGE OF CATIONS".

The ability of a sediment or soil to exchange cation is expressed as the CATION EXCHANGE CAPACITY (CEC).

"The no. of milli-equivalent (meq) of monovalent cations that can be exchanged per 100g of soil (on a dry weight-basis).

Both the minerals & organic portions of soils exchange cations. Minerals due to the presence of -vely charged sites on them, & Organic materials due to presence of the carboxylate group & other basic functional groups. Humus typically has a very high CEC.

The value of CEC for soils with more typical levels of org matter are around 10-30 meq/100g.

Cation exchange in soil as the mechanism by which K^+, Ca^{+2}, Mg^{+2} & essential trace level metals are made available to plants.

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When nutrient metal ions are taken up by plant roots, H^+ ion is exchanged for the metal ions. This process plus the leaching of Ca^{+2}, Mg^{+2} & other metal ions from the soil by water containing Carbonic acid tends to make the soil acidic.

The exchange of ANIONS by soil is not nearly as clearly defined as is the exchange of cations. In many cases, the exchange of anions does not involve a simple ion exchange process. This is true of the strong retention of Orthophosphate species by soil. At the other end of the ~~Nitrate~~ NO_3^- ion is very weakly retained by the soil.

Anion exchange may be visualized as occurring at the surface of oxides in the mineral portion of soil. At low pH the oxide surface have a net +ve charge, enabling it to hold anions as Cl^- by the electrostatic attraction. At High pH the metal oxide surface has a net −ve charge due to the formation of OH^- ion on the surface caused by loss of H^+ from water molecules bound to the surface. In such cases ~~as HPO~~ it is possible for anion such as HPO_4^{-2} to displace OH^- ions & bound directly to the oxide surface.

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★ Soil Pollution:-

The problem of soil pollution differs from air & water pollution in the respect that the pollutants remain in direct contact with the soil for relatively longer period. The wide spread industrialization and increasing consumption have changed the very complexion of soil. The soil is getting heavily polluted day by day by toxic materials and dangerous micro-organisms which enter the air, water and food chain. Man is the original and basic pollutant responsible for pollution hazards and toxic effects.

Sources Of Soil Pollution:-

Soil pollution mainly results from the following sources. ① Industrial Waste ② Urban Waste ③ Radioactive Pollutants ④ Agricultural practices ⑤ Chemical and mettalic pollutants ⑥ Biological agents ⑦ Mining ⑧ Resistant objects eg cans, plastics, tyres, glasses, old cars, scrap iron etc when dumped into nature destroy the beauty of landscape ⑨ Soil sediments caused by erosion

① Soil Pollution By Industrial Waste:-

Disposal of industrial waste is the major problem responsible for soil pollution. These industrial pollutants are mainly discharged from

i)= Pulp & paper mills ii)= Chemical industries

iii)= Oil refineries iv)= Sugar factories

v)= Tanneries vi)= Textiles

13) Municipal waste or Urban waste:- Urban waste comprises of commercial & domestic wastes consisting of dried sludge of sewage & solid wastes called Refuse. This Refuse consists of Garbage, rubbish, materials like street sweepings, fuel residues, abandoned vii) steel viii) Fertilizers, pesticides industries ix) Coal & mineral mining industries x) Drug, glass, cement, petroleum & engineering industries.

⇒ With the advent of technology newer types of industrial wastes are produced and deposited on the land. These waste products are also tipped on soil, enhancing the extent of soil pollution.

ELECTRIC POWER PLANTS:-

The Furnaces of electric power plants generates Flyash i.e. Unburnt brownish black substance which pollute water, air & soil.

⇒ Many industrial effluents are discharged into streams or dumped into surrounding land.

⇒ Industrial waste mainly consists of organic compounds alongwith inorganic complexes and non-biodegradable materials. These pollutants effects & alter the chemical and biological properties of soil. As a result, hazardous chemicals can enter into human food chains from the soil or water, disturb the biochemical process and finally lead to serious effects on living organisms.

⇒ The industrial effluents contains heavy metals, radioactive substances, toxic waste, oil, PCBs, These are absorbed by the vegetables & make

vehicles ... disposed off separately from industrial wastes can still be dangerous. This is b/c they can be easily degraded

PLASTIC BAGS are a major part of the solid urban waste. They pollute the environment & are health hazard b/c (1) they are non-biodegradable (2) exert (3) them unfit for human use.

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These wastes has also gone down considerably because of hazardous liquid effluents for irrigation. The saline content of the surrounding ground was is so high that it has become totally unfit for irrigation.

CEMENT AND STEEL INDUSTRIES:-

They disturb the (1) salt balance of soil & (2) destroy its fertility. The (3) alkalinity of the soil is increased and the (4) heavy metals and certain chemical compounds may reach soil and enter plants causing bioaccumulation which are health hazards.

EXAMPLE :- (Pb) content in the soil may result in the risk of neurobehavioural effects in children.

Industrial sludges are even more dangerous than industrial solid waste to dispose of tidily. These wastes contains $CaCO_3$ & calcium salts & several toxic volatile elements such as Arsenic, Mercury, Pb, Cd which pose detrimental effects on the environment.

DETRIMENTAL EFFECTS OF INDUSTRIAL POLLUTION

→ Industrial effluents have variety of chemicals which are extremely toxic to living beings. These toxicants are transferred to different organisms

toxic gases on burning, inhalation of which leads to the lung infection, bronchitis & even cancer. (3) They contain harmful chemical dyes & pigments. They contaminate the food causing food poisoning, kidney damage etc in their food chain causing a number of undesirable effects.

(2) ⇒ Industrial effluents will poison the biological purification mechanism of sewage treatment causing several soil and water born diseases.

(3) ⇒ Amino acids, albumins and gelatins release S & P compounds. These compounds produce SO_2, H_2S & oxides of phosphorus which cause musty & putrid smell in soil.

(4) ⇒ Most of the food grains are uneatable due to synthetic chemicals in USA & other countries.

(5) ⇒ Soluble salt can cause crop less, soil less, mettalic corrosion and lead to costly cleaning activities.

(6) ⇒ Mettalic contaminents destroy bacteria and beneficial micro organisms in the soil.

(7) ⇒ High acidity and alkalinity of soil coming from chemical industries can cause severe agricultural crop damage.

(8) ⇒ Industrial effluents like As, Pb & CN cause cellular degradation in ~~soil~~ brain which results in Figidity, fatigue coma, and numbness, nuisance.

(9) ⇒ Pathogenic bacteria coming from tanneries reach the soil where they have significant effect on plants & animals & causing a disruption in plant species.

(4) May check drainage system (5) May prevent plant growth. Much of the SO_2 evolved during burning of S. containing fuel ends up on soil as sulphates (Pb) From Pb ores & smelters occurs at elevated levels in soil near industrial areas affecting plants like Plants & Vegetables

(2) Soil Pollution By Agricultural Particles (41) (241)

Today with the advancing agrotechnology, huge quantities of Fertilizers, pesticides, herbicides, weedicides and soil conditioning agents are employed to increase the crop yield soil conditioners, Fumigants & other chemical agents have Pb As, Cd, Hg, to accumulate in soil Many agricultural lands have now excessive amounts of plants and animal wastes which are posing soil pollution problem. Apart from these soil wastes, debris soil erosion containing mostly inorganic chemicals are reported to cause soil pollution

N.B. Prepare Fertilizers, Pesticides, herbicides, Fungicides etc from Page 26 → 36 of water pollution with necessary changes i.e. Discuss soil only, not add water.

(3) Soil Pollution By Mining

In surface mining and strip mining man has removes top soil and subsoil. This leaves deep salts in the earth. The uncontrolled mine (Fire) may also destroy the productivity of certain land areas permanently.

Due to mining vegetation has removed & huge quantities of top soil and rocks are to be shifted to a new location. Mining leads to a

- Loss of grazing & fertile land
- Soil erosion from waste dumps

also add poison to urban waste.

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⇒ sedimentation or siltation

⇒ Danger to aquatic life

⇒ Damage to flora and fauna as well as water and soil pollution.

⇒ It has also resulted in displacing a large section of people from their resources base.

⇒ Since the mines are mostly in forest areas, they seriously affect the symbiotic relationship existing b/w tribals & forest. Mining would result high evolution of CO_2, changing green house effect, ACID RAIN, GLOBAL WARMING & over all climate changes.

⇒ Mining activities can cause ecological damage and affect natural biodiversity leading to erosion of environmental richness

⇒ Nitrogen fixing leguminous plants like Acacia show rapid growth action by broadcasting seeds of shrubs and grass around the mining dumps and other areas & help in improving soil quality.

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✱ Reclamation Of Soil

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Water Logging:-

The heavy amounts of water percolates into the soil due to excessive irrigation or rain fall, the water level in water table or aquifer rises. This process is called water logging. OR Rise in water table is called water logging. Water logged soil is that soil, whose surface layer are saturated with the water, in such soils the spaces b/w the soil particles are occupied by water instead of air.

① Reclamation Of Water Logged Soil:-

⇒ Following measures can be adopted for reclamation of water logged soil.

① Canal Closure During Winter:-

In 1926 Wilsdon and Sarthy reported that canal closure were effective measures to control rising ground water. It was suggested that the canals be closed during water winter.

② Lowering The Full Supply Levels Of Canal

The lowering of full supply levels of canals by many feet produced good effect. As experiment, the upper chenab canal was diverted in Deak, to lower the full supply level by several feet

3) Seepage Intercepter Drains:-

In 1930 drains were constructed along both sides of upper chenab canal at the foot of spoil banks. The idea was to intercept seepage from the canal towards the neighbouring soil.

4) Surface Drains:-

Surface drains proved very effective, because the surface water is accumulated as a result of seepage from canal and rain fall was drained out of this locality and the soil was partly reclaimed.

5) Lining Of Canals:-

Lining of canals with the impervious materi-al also helpful in reducing the seepage.

In 1938-39 Haveli canal bed was lined with two layers of tiles placed one above the other. Between the two layers was a layer of cement sand plaster.

6) Pumping Of Ground Water:-

High levels of ground water can quickly be lowered with the help of this device. This measures also makes additional water available for irrigation.

Sources :- [illegible] irrigation water
Excess water in water logged soil, Flood water
Primary salinity
Secondary salinity

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② SALT AFFECTED SOIL (SALINE)

"The soil in which the concentration of salts is very high are called salt affected soils." Such soils are abnormal because plants can not grow properly in such soils.

RECLAMATION OF SALT AFFECTED SOIL :-

Def "The soil can be put to use or can be brought back to their normal state for cultivation. This process is called reclamation."

The measures adopted for reclamation or restoring the salt affected soil depends on their
(a) nature i.e. ① Saline ② Saline-sodic or ③ sodic soils
(b) on the causes of their formation.

(i) Reclamation of saline soil :-

The saline soil contains chlorides and sulphates of sodium and potassium. These salts are soluble in water.

FLUSHING :-

The salts can be leached out of the soil with the application of water and providing drainage. This process is called flushing. This process leach the salts below the root zone.

Proper drainage is applied to avoid waterlogging.

Flushing with high amount of water while planting (rice seedlings) is helpful in recovery of saline soil within two or three seasons.

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Nitrogen deficiency appears in the rice field on account of waterlogging. organic matter is not decomposed due to lack of activity of aerobic micro-organisms and nitrogen remains locked up in the organic matter. To make the good deficiency of Nitrogen, certain leguminous plants may be grown after the rice crop.

RECLAMATION OF SODIC SOILS:-

Sodic soils are those which contain sufficient exchangeable sodium to interfere with the growth of most crop plants and not containing appreciable quantities of soluble salts.

Saline sodic soils are these soils containing soluble salts in quantities sufficient to interfere with the growth of most crop plants.

The sodic and saline sodic soils can be reclaimed by leaching or flushing with water only if the exchangeable Na^+ is replaced with Ca^{++} by addition of suitable amendments.

The amendments applied to the saline sodic & sodic soils are either (1) direct source of soluble calcium e.g gypsum or (2) indirect they first Reacts with the soil's calcium and release soluble calcium, which then replaces sodium.

CHEMICAL AMENDMENTS

The amendments may be chemical or biologic The commonly used chemicals are gypsum, sulphuric acid, sulphur and iron sulphate. Since all saline sodic soils in PAKISTAN are calcareous, the following reactions occure on adding chemical amendments to the soil.

(1) $CaSO_4 + [CLAY]^{Na^+}_{Na^+} \longrightarrow [clay]^{Ca^{++}} + Na_2SO_4 \downarrow$

leached with water

(2) $2S + 3O_2 + H_2O \longrightarrow H_2SO_4 + SO_3$ ---(i)

$H_2SO_4 + CaCO_3 \longrightarrow CaSO_4 + H_2O + CO_2$ ---(ii)

(in the soil) (gypsum)

$CaSO_4 + [clay]^{Na^+}_{Na^+} \longrightarrow [clay]^{Ca^{++}} + Na_2SO_4 \downarrow$ ---(iii)

(leached)

(3) $H_2SO_4 + [clay]^{Na^+}_{Na^+} \longrightarrow [clay]^{H^+}_{H^+} + Na_2SO_4 \downarrow$

(leached)

The rate of application of amendments depends upon the amount of exchangeable sodium that is to be replaced.

BIOLOGICAL AMENDMENTS:

Sesbania sesban (Jantar) is a salt tolerent fodder crop. It can grow in alkali soils. The respiration of its roots produces (CO_2) which reacts with calcium carbonate present in the calcareous soil in

the presence of water to produce soluble calcium bicarbonate, $Ca(HCO_3)_2$ can exchange its calcium ions with sodium ions so as to reduce sodicity as expressed in the following reaction.

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

$$Ca(HCO_3)_2 + [clay]^{Na^+} \longrightarrow [clay]^{Ca^{++}} + 2NaHCO_3$$

leached.

Biological amendments can be applied on calcarious alkali soils only or it may be used by adding chemical amendments in the form of $CaCl_2$. This is the cheapest measure for reclaiming sodic soils. The (gypsum) is the next best.

(3) Another cheaper method is the use of (green manure) (GM) or farm yard manure (FYM). This method is called organic amendment.

ORGANIC AMENDMENT:-

Sesbania sesban (Jantar) or Dipla-chana Fusca (Kallar grass) are two highly tole--rent crops of saline and sodic soils. They can absorb large quantities of salts through their roots and hence reduce bad effects of salts in the soil.

Kallar grass may also be used as GM On decomposition it produces (humic acid) which

converts $CaCO_3$ of the sodic soil into soluble bicarbonate of calcium. Calcium replaces sodium adsorbed on the colloidal complex of the soil. Sodium bicarbonate is then leached away with water & soil is improved.

Humic acid

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

$$Ca(HCO_3)_2 + \underset{\text{clay}}{\underset{|}{Na}\,Na} \longrightarrow \underset{\text{clay}}{Ca} + 2NaHCO_3 \downarrow$$

leached away


PUACP