



## STUDY THE PHYSICO-CHEMICAL PARAMETERS IN SOIL SAMPLES OF KAWARDHA, CHHATTISGARH, INDIA.

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### ABSTRACT

Soil is a natural body consisting of layers (soil horizons) that are primarily composed of minerals, mixed with at least some organic matter, which differ from their parent materials in their texture, structure, consistency, color, chemical, biological and other characteristics. It is the unconsolidated or loose covering of fine rock particles that covers the surface of the earth. Soil is the end product of the influence of the climate, relief (slope), organisms, parent materials (original minerals), and time. In engineering terms, soil is referred to as regolith, or loose rock material that lies above the 'solid geology'. In horticulture, the term 'soil' is defined as the layer that contains organic material that influences and has been influenced by plant roots, and may range in depth from centimetres to many metres.

### INTRODUCTION

Soil is composed of particles of broken rock (parent materials) which have been altered by physical, chemical and biological processes that include weathering with associated erosion. Soil is created from the alteration of parent material by the interactions between the lithosphere, hydrosphere, atmosphere, and biosphere. It can also be considered a mixture of mineral and organic materials in the form of solids, gases and liquids. Soil is commonly referred to as "earth" or "dirt"; technically, the term "dirt" should be restricted to displaced soil.

Soil forms a structure filled with pore spaces and can be thought of as a mixture of solids, water, and gases. Accordingly, soils are often treated as a three-state system. Most soils have a density between 1 and 2 g/cm<sup>3</sup>. Little of the soil of planet Earth is older than the Pleistocene and none is older than the Cenozoic, although fossilized soils are preserved from as far back as the Archean.

### History of the study of soil

The history of the study of soil is intimately tied

to our urgent need to provide food for ourselves and forage for our animals. Throughout history, civilizations have prospered or declined as a function of the availability and productivity of their soils.

The Greek historian Xenophon (450–355 B.C.) is credited with being the first to expound upon the merits of green-manuring crops: "But then whatever weeds are upon the ground, being turned into earth, enrich the soil as much as dung."

Columella's "Husbandry," circa 60 A.D., advocated the use of lime and that clover and alfalfa (green manure) should be turned under, and was used by 15 generations (450 years) under the Roman Empire until its collapse. From the fall of Rome to the French Revolution, knowledge of soil and agriculture was passed on from parent to child and as a result, crop yields were low. During the European Dark Ages, Yahya Ibn al-'Awwam's handbook guided the people of North Africa, Spain and the Middle East with its emphasis on irrigation; a translation of this work was finally carried to the southwest of the United States.

Experiments into what made plants grow first led to the idea that the ash left behind when plant matter was burned was the essential element but overlooked the role of nitrogen, which is not left on the ground after combustion.

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Research Article



In about 1635, the Flemish chemist Jan Baptist van Helmont thought he had proved water to be the essential element from his famous five years' experiment with a willow tree grown with only the addition of rainwater. His conclusion came from the fact that the increase in the plant's weight had been produced only by the addition of water, with no reduction in the soil's weight. John Woodward experimented with various types of water ranging from clean to muddy and found muddy water the best, and so he concluded that earthy matter was the essential element. Others concluded it was humus in the soil that passed some essence to the growing plant. Still others held that the vital growth principal was something passed from dead plants or animals to the new plants. At the start of the 18th century, Jethro Tull demonstrated that it was beneficial to cultivate the soil, but his opinion that the stirring made the fine parts of soil available for plant absorption was erroneous.

### STUDIES CONCERNING SOIL FORMATION

The scientists who studied the soil in connection with agricultural practices had considered it mainly as a static substrate. However, soil is the result of evolution from more ancient geological materials. After studies of the improvement of the soil commenced, others began to study soil genesis and as a result also soil types and classifications.

In 1860, in Mississippi, Eugene W Hilgard studied the relationship among rock material, climate, and vegetation, and the type of soils that were developed. He realised that the soils were dynamic, and considered soil types classification. Unfortunately his work was not continued. At the same time Vasily Dokuchaev (about 1870) was leading a team of soil scientists in Russia who conducted an extensive survey of soils, finding that similar basic rocks, climate and vegetation types lead to similar soil layering and types, and established the concepts for soil classifications. Due to the language barriers, the work of this team was not communicated to Western Europe until 1914 by a publication in German by K. D. Glinka, a member of the Russian team.

Curtis F. Marbut was influenced by the work of the Russian team, translated Glinka's publication into English, and as he was placed in charge of the U. S. National Cooperative Soil Survey, applied it to a national soil classification system.

### INFLUENCES ON SOIL FORMATION

Soil formation, or pedogenesis, is the combined effect of physical, chemical, biological and anthropogenic processes on soil parent material. Soil is said to be formed when organic matter has accumulated and colloids are washed downward, leaving deposits of clay, humus, iron oxide, carbonate, and gypsum. These constituents are moved from one level to another by water and animal activity.

As a result, layers (horizons) form in the soil profile. The alteration and movement of materials within a soil causes the formation of distinctive soil horizons.

How soil formation proceeds is influenced by at least five classic factors that are intertwined in the evolution of a soil. They are: parent material, climate, topography (relief), organisms, and time. When reordered to climate, relief, organisms, parent material, and time, they form the acronym CROPT.

An example of the development of a soil would begin with the weathering of lava flow bedrock, which would produce the purely mineral-based parent material from which the soil texture forms. Soil development would proceed most rapidly from bare rock of recent flows in a warm climate, under heavy and frequent rainfall. Under such conditions, plants become established very quickly on basaltic lava, even though there is very little organic material. The plants are supported by the porous rock as it is filled with nutrient-bearing water that carries dissolved minerals from the rocks and guano. Crevasses and pockets, local topography of the rocks, would hold fine materials and harbour plant roots. The developing plant roots are associated with mycorrhizal fungithat assist in breaking up the porous lava, and by these means organic matter and a finer mineral soil accumulate with time.

### PARENT MATERIAL

The mineral material from which a soil forms is called parent material. Rock, whether its origin is igneous, sedimentary, or metamorphic, is the source of all soil mineral materials and origin of all plant nutrients with the exceptions of nitrogen, hydrogen and carbon. As the parent material is chemically and physically weathered, transported, deposited and precipitated, it is transformed into a soil.

#### Typical soil mineral materials are:

- Quartz:  $\text{SiO}_2$
- Calcite:  $\text{CaCO}_3$
- Feldspar:  $\text{KAlSi}_3\text{O}_8$
- Mica (biotite):  $\text{K}(\text{Mg,Fe})_3\text{AlSi}_3\text{O}_{10}(\text{OH})_2$

### CLASSIFICATION AND WEATHERING OF PARENT MATERIAL

Parent materials are classified according to how they came to be deposited. Residual materials are mineral materials that have weathered in place from primary bedrock. Transported materials are those that have been deposited by water, wind, ice or gravity. And cumulose material is organic matter that has grown and accumulates in place. Residual soils are soils that develop from their underlying parent rocks and have the same general chemistry as those rocks. The soils found on mesas, plateaux, and plains are residual soils. In the United States as little as three percent of the soils are residual.



Most soils derive from transported materials that have been moved many miles by wind, water, ice and gravity.

- Aeolian processes (movement by wind) are capable of moving silt and fine sand many hundreds of miles, forming loess soils (60–90 percent silt), common in the Midwest of North America and in Central Asia. Clay is seldom moved by wind as it forms stable aggregates.
- Water-transported materials are classed as either alluvial, lacustrine, or marine. Alluvial materials are those moved and deposited by flowing water. Sedimentary deposits settled in lakes are called lacustrine. Lake Bonneville and many soils around the Great Lakes of the United States are examples. Marine deposits, such as soils along the Atlantic and Gulf Coasts and in the Imperial Valley of California of the United States, are the beds of ancient seas that have been revealed as the land uplifted.
- Ice moves parent material and makes deposits in the form of terminal and lateral moraines in the case of stationary glaciers. Retreating glaciers leave smoother ground moraines and in all cases, outwash plains are left as alluvial deposits are moved downstream from the glacier.
- Parent material moved by gravity is obvious at the base of steep slopes as talus cones and is called colluvial material.

Cumulose parent material is not moved but originates from deposited organic material. This includes peat and muck soils and results from preservation of plant residues by the low oxygen content of a high water table. While peat may form sterile soils, muck soils may be very fertile.

The weathering of parent material takes the form of physical disintegrating and chemical decomposition and transformation. Physical disintegration begins as rocks that have solidified deep in the earth are exposed to lower pressure near the surface and they swell and become unstable. Chemical decomposition rates double with each 10°C rise in temperature but is strongly dependent on water to effect chemical changes. Rocks that will decompose in a few years in tropical climates will remain unaltered for millennia in deserts.

- Physical disintegration is the first stage in the transformation of parent material into soil. The freezing of absorbed water causes the physical splitting of material along a path toward the center of the rock, while temperature gradients within the rock can cause exfoliation of "shells". Cycles of wetting and drying cause soil particles to be abraded to a finer size, as does the physical rubbing of material as it is moved by wind, water, and gravity. Organisms also reduce parent material in size through the action of plant roots or digging on the part of animals.
- Chemical decomposition results when minerals are made soluble by water or are changed in structure. The first three of the following list are solubility changes and the last three are structural changes.

1. The solution of salts in water results from the action of bipolar water on ionic salt compounds.
2. Hydrolysis is the transformation of minerals into polar molecules by the splitting of the intervening water. This results in soluble acid-base pairs. For example, the hydrolysis of orthoclase-feldspar transforms it to acid silicate clay and basic potassium hydroxide, both of which are more soluble.
3. In carbonation, the reaction of carbon dioxide in solution with water forms carbonic acid. Carbonic acid will transform calcite into more soluble calcium bicarbonate.
4. Hydration is the inclusion of water in a mineral structure, causing it to swell and leaving it more stressed and easily decomposed.
5. Oxidation of a mineral compound causes it to swell and increase its oxidation number, leaving it more easily attacked by water or carbonic acid.
6. Reduction means the oxidation number of some part of the mineral is reduced, which occurs when oxygen is scarce. The reduction of minerals leaves them electrically unstable, more soluble and internally stressed and easily decomposed.

## CLIMATE

Climate is the dominant factor in soil formation, and soils show the distinctive characteristics of the climate zones in which they form. Mineral precipitation and temperature are the primary climatic influences on soil formation.

The direct influences of climate include

A shallow accumulation of lime in low rainfall areas as caliche

- Formation of acid soils in humid areas
- Erosion of soils on steep hillsides
- Deposition of eroded materials downstream
- Very intense chemical weathering, leaching, and erosion in warm and humid regions where soil does not freeze

## TOPOGRAPHY

The topography, or relief, characterized by the inclination of the surface, determines the rate of precipitation runoff and rate of formation or erosion of the surface soil profiles. Steep slopes allow rapid runoff and erosion of the top soil profiles and little mineral deposition in lower profiles. Depressions allow the accumulation of water, minerals and organic matter and in the extreme, the resulting soils will be saline marshes or peat bogs. Intermediate topography affords the best conditions for the formation of an agriculturally productive soil.

## ORGANISMS

Soil is the most abundant ecosystem on Earth, but the vast majority of organisms in soil are microbes, a great many of which have not been described. There may be a population limit of around one billion cells per gram of



soil, but estimates of the number of species vary widely. One estimate put the number at over a million species per gram of soil, although a later study suggests a maximum of just over 50,000 species per gram of soil. The total number of organisms and species can vary widely according to soil type, location, and depth.

### PHYSICAL PROPERTIES OF SOILS

The physical properties of soils, in order of decreasing importance, are texture, structure, density, porosity, consistency, temperature, colour and resistivity. Most of these determine the aeration of the soil and the ability of water to infiltrate and to be held in the soil. Soil texture is determined by the relative proportion of the three kinds of soil particles, called soil "separates": sand, silt, and clay. Larger soil structures called "peds" are created from the separates when iron oxides, carbonates, clay, and silica with the organic constituent humus, coat particles and cause them to adhere into larger, relatively stable secondary structures. Soil density, particularly bulk density, is a measure of soil compaction. Soil porosity consists of the part of the soil volume occupied by gases and water. Soil consistency is the ability of soil to stick together. Soil temperature and colour are self-defining. Resistivity refers to the resistance to conduction of electric currents and affects the rate of corrosion of metal and concrete structures. The properties may vary through the depth of a soil profile.

### SOIL TEXTURE

The mineral components of soil, sand, silt and clay, determine a soil's texture. In the illustrated USDA textural classification triangle, the only soil that does not exhibit one of these predominately is called "loam". While even pure sand, silt or clay may be considered a soil, from the perspective of food production a loam soil with a small amount of organic material is considered ideal. The mineral constituents of a loam soil might be 40% sand, 40% silt and the balance 20% clay by weight. Soil texture affects soil behaviour, in particular its retention capacity for nutrients and water.

Sand and silt are the products of physical and chemical weathering; clay, on the other hand, is a product of chemical weathering but often forms as a secondary mineral precipitated from dissolved minerals. It is the specific surface area of soil particles and the unbalanced ionic charges within them that determine their role in the cation exchange capacity of soil, and hence its fertility. Sand is least active, followed by silt; clay is the most active. Sand's greatest benefit to soil is that it resists compaction and increases porosity. Silt is mineralogically like sand but with its higher specific surface area it is more chemically active than sand. But it is the clay content, with its very high specific surface area and generally large number of negative charges, that gives a soil its high retention capacity for water and nutrients. Clay soils also

resist wind and water erosion better than silty and sandy soils, as the particles are bonded to each other.

Sand is the most stable of the mineral components of soil; it consists of rock fragments, primarily quartz particles, ranging in size from 2.0 to 0.05 mm (0.079 to 0.0020 in) in diameter. Silt ranges in size from 0.05 to 0.002 mm (0.002 to 0.00008 in). Clay cannot be resolved by optical microscopes as its particles are 0.002 mm ( $7.9 \times 10^{-5}$  in) or less in diameter. In medium-textured soils, clay is often washed downward through the soil profile and accumulates in the subsoil.

Figure 1. Soil Texture



### DENSITY

Density is the weight per unit volume of an object. Particle density is the density of only the mineral particles that make up a soil; i.e., it excludes pore space and organic material. Particle density averages approximately 2.65 g/cc (165 lbm/ft<sup>3</sup>). Soil bulk density, a dry weight, includes air space and organic materials of the soil volume. A high bulk density indicates either compaction of the soil or high sand content. The bulk density of cultivated loam is about 1.1 to 1.4 g/cc (for comparison water is 1.0 g/cc). A lower bulk density by itself does not indicate suitability for plant growth due to the influence of soil texture and structure.

Table 1. Representative bulk densities and percentage pore space

Representative bulk densities of soils. The percentage pore space was calculated using 2.7 g/cc for particle density except for the peat soil, which is estimated.		
Soil treatment and identification	Bulk density g/cc	Pore space %
Tilled surface soil of a cotton field	1.3	51
Trafficked inter-rows where wheels passed surface	1.67	37
Traffic pan at 25 cm deep	1.7	36
Undisturbed soil below traffic pan, clay loam	1.5	43
Rocky silt loam soil under aspen forest	1.62	40
Loamy sand surface soil	1.5	43
Decomposed peat	0.55	65



## POROSITY

Pore space is that part of the bulk volume that is not occupied by either mineral or organic matter but is open space occupied by either gases or water. Ideally, the total pore space should be 50% of the soil volume. The gas space is needed to supply oxygen to organisms decomposing organic matter, humus, and plant roots. Pore space also allows the movement and storage of water and dissolved nutrients.

There are four categories of pores:

1. Very fine pores: < 2 microns
2. Fine pores: 2-20 microns
3. Medium pores: 20-200 microns
4. Coarse pores: 200 microns-0.2 mm

In comparison, root hairs are 8 to 12 microns in diameter. When pore space is less than 30 microns, the forces of attraction that hold water in place are greater than those acting to drain the water. At that point, soil becomes water-logged and it cannot breathe. For a growing plant, pore size is of greater importance than total pore space. A medium-textured loam provides the ideal balance of pore sizes. Having large pore spaces that allow rapid gas and water movement is superior to smaller pore space but has a greater percentage pore space. Tillage has the short-term benefit of temporarily increasing the number of pores of largest size, but in the end those will be degraded by the destruction of soil aggregation.

## SOIL WATER

Water affects soil formation, structure, stability and erosion but is of primary concern with respect to plant growth. Water is essential to plants for four reasons:

1. It constitutes 85%-95% of the plant's protoplasm.
2. It is essential for photosynthesis.
3. It is the solvent in which nutrients are carried to, into and throughout the plant.
4. It provides the turgidity by which the plant keeps itself in proper position.

In addition, water alters the soil profile by dissolving and re-depositing minerals, often at lower levels, and possibly leaving the soil sterile in the case of extreme rainfall and drainage. In a loam soil, solids constitute half the volume, gas one-quarter of the volume, and water one-quarter of the volume of which only half will be available to most plants.

A flooded field will drain the gravitational water under the influence of gravity until water's adhesive and cohesive forces resist further drainage and it finally reaches field capacity. Plants must apply suction to draw water from a soil. When soil becomes too dry, the available water is used up and the remaining moisture is unavailable water as the plant cannot produce sufficient suction. A plant must produce suction that increases from zero for a flooded field to 1/3 bar at field dry condition. At 15 bar suction, wilting percent, plants begin to die. Water moves in soil under the influence of gravity, osmosis and capillarity.

The rate at which a soil can absorb water depends on the soil and its other conditions. When saturated, the soil may lose nutrients as the water drains. Water moves in a drained field under the influence of pressure where the soil is locally saturated and of capillarity pull. Most plant water needs are supplied from the suction of evaporation from plant leaves and 10% is supplied by "suction" created by osmotic pressure. Plant roots must seek out water. Insufficient water will damage the yield of a crop. Most of the available water is used in transpiration to pull nutrients into the plant.

## WATER RETENTION FORCES

Water is retained in a soil when the adhesive force of attraction of water for soil particles and the cohesive forces water feels for itself are capable of resisting the force of gravity which tends to drain water from the soil. When a field is flooded, the air space is displaced by water. The field will drain under the force of gravity until it reaches what is called field capacity, at which point the smallest pores are filled with water and the largest with water and gases. The total amount of water held when field capacity is reached is a function of the specific surface area of the soil particles. As a result, high clay and high organic soils have higher field capacities. The total force required to pull or push water out of soil is termed suction and usually expressed in units of bars ( $10^5$  pascal) which is just a little less than one-atmosphere pressure. Alternatively, the terms "tension" or "moisture potential" may be used.

## SOIL ATMOSPHERE

The atmosphere of soil is radically different from the atmosphere above. The consumption of oxygen, by microbes and plant roots and their release of carbon dioxide, decrease oxygen and increase carbon dioxide concentration. Atmospheric  $\text{CO}_2$  concentration is 0.03%, but in the soil pore space it may range from 10 to 100 times that level. At extreme levels  $\text{CO}_2$  is toxic. In addition, the soil voids are saturated with water vapour. Adequate porosity is necessary not just to allow the penetration of water but also to allow gases to diffuse in and out. Movement of gases is by diffusion from high concentrations to lower. Oxygen diffuses in and is consumed and excess levels of carbon dioxide, diffuse out with other gases as well as water. Soil texture and structure strongly affect soil porosity and gas diffusion. Platy and compacted soils impede gas flow, and a deficiency of oxygen may encourage anaerobic bacteria to reduce nitrate to the gases  $\text{N}_2$ ,  $\text{N}_2\text{O}$ , and  $\text{NO}$ , which are then lost to the atmosphere. Aerated soil is also a net sink of methane  $\text{CH}_4$  but a net producer of greenhouse gases when soils are depleted of oxygen and subject to elevated temperatures.

## CHEMICAL AND COLLOIDAL PROPERTIES

The chemistry of soil determines the availability of nutrients, the health of microbial populations, and its



physical properties. In addition, soil chemistry also determines its corrosivity, stability, and ability to absorb pollutants and to filter water. It is the surface chemistry of clays and humus colloids that determines soil's chemical properties. The very high specific surface area of colloids and their net negative charges, gives soil its great ability to hold and release cations in what is referred to as cation exchange. Cation-exchange capacity (CEC) is the amount of exchangeable cations per unit weight of dry soil and is expressed in terms of milliequivalents of hydrogen ion per 100 grams of soil. "A colloid is a small, insoluble, nondiffusible particle larger than a molecule but small enough to remain suspended in a fluid medium without settling. Most soils contain organic colloidal particles called humus as well as the inorganic colloidal particles of clays."

### SOIL pH

At 25°C an aqueous solution that has a pH of 3.5 has  $10^{-3.5}$  moles  $H^+$  (hydrogen ions) per litre of solution (and also  $10^{-10.5}$  mole/litre  $OH^-$ ). A pH of 7, defined as neutral, has  $10^{-7}$  moles hydrogen ions per litre of solution and also  $10^{-7}$  moles of  $OH^-$  per litre; since the two concentrations are equal, they are said to neutralise each other. A pH of 9.5 is  $10^{-9.5}$  moles hydrogen ions per litre of solution (and also  $10^{-2.5}$  mole per litre  $OH^-$ ). A pH of 3.5 has one million times more hydrogen ions per litre than a solution with pH of 9.5 ( $9.5 - 3.5 = 6$  or  $10^6$ ) and is more acidic.

The effect of pH on a soil is to remove from the soil or to make available certain ions. Soils with high acidity tend to have toxic amounts of aluminium and manganese. Plants which need calcium need moderate alkalinity, but most minerals are more soluble in acid soils. Soil organisms are hindered by high acidity, and most agricultural crops do best with mineral soils of pH 6.5 and organic soils of pH 5.5.

In high rainfall areas, soils tend to acidity as the basic cations are forced off the soil colloids by the mass action of hydrogen ions from the rain as those attach to the colloids. High rainfall rates can then wash the nutrients out, leaving the soil sterile. Once the colloids are saturated with  $H^+$ , the addition of any more hydrogen ions or aluminum hydroxyl cations drives the pH even lower (more acidic) as the soil is left with no buffering capacity. In extreme rainfall areas and high temperatures, the clay and humus may be washed out, further reducing the buffering capacity of the soil. In low rainfall areas, unleached calcium pushes pH to 8.5 and with the addition of exchangeable sodium, soils may reach pH 10. Beyond a pH of 9, plant growth is reduced. High pH results in low micro-nutrient mobility, but water-soluble chelates of those nutrients can supply the deficit. Sodium can be reduced by the addition of gypsum (calcium sulphate) as calcium adheres to clay more tightly than does sodium causing sodium to be pushed into the soil water solution where it

can be washed out by an abundance of water.

### BASE SATURATION PERCENTAGE

There are acid-forming cations (hydrogen and aluminium) and there are base-forming cations. The fraction of the base-forming cations that occupy positions on the soil colloids is called the base saturation percentage. If a soil has a CEC of 20 meq and 5 meq are aluminium and hydrogen cations (acid-forming), the remainder of positions on the colloids ( $20 - 5 = 15$  meq) are assumed occupied by base-forming cations, so that the percentage base saturation is  $15/20 \times 100\% = 75\%$  (the complement 25% is assumed acid-forming cations). When the soil pH is 7 (neutral), base saturation is 100 percent and there are no hydrogen ions stored on the colloids. Base saturation is almost in direct proportion to pH (increases with increasing pH). It is of use in calculating the amount of lime needed to neutralise an acid soil. The amount of lime needed to neutralize a soil must take account of the amount of acid forming ions on the colloids not just those in the soil water solution. The addition of enough lime to neutralize the soil water solution will be insufficient to change the pH, as the acid forming cations will tend to restore the original pH condition as they are pushed off the soil colloids by the calcium of the added lime.

### BUFFERING OF SOILS

The resistance of soil to changes in pH and available cations from the addition of acid or basic material is a measure of the buffering capacity of a soil and increases as the CEC increases. Hence, pure sand has almost no buffering ability, while soils high in colloids have high buffering capacity. Buffering occurs by cation exchange and neutralisation.

The addition of a small amount highly basic aqueous ammonia to a soil will cause the ammonium to displace hydrogen ions from the colloids, and the end product is water and colloiddally fixed ammonium, but no permanent change overall in soil pH.

The addition of a small amount of lime,  $CaCO_3$ , will displace hydrogen ions from the soil colloids, causing the fixation of calcium to colloids and the evolution of  $CO_2$  and water, with no permanent change in soil pH.

The addition of carbonic acid (the solution of  $CO_2$  in water) will displace calcium from colloids, as hydrogen ions are fixed to the colloids, evolving water and slightly alkaline (temporary increase in pH) highly soluble calcium bicarbonate, which will then precipitate as lime ( $CaCO_3$ ) and water at a lower level in the soil profile, with the result of no permanent change in soil pH.

All of the above are examples of the buffering of soil pH. The general principal is that an increase in a particular cation in the soil water solution will cause that cation to be fixed to colloids (buffered) and a decrease in solution of that cation will cause it to be withdrawn from the colloid and moved into solution (buffered). The degree



of buffering is limited by the CEC of the soil; the greater the CEC, the greater the buffering capacity of the soil.

## DEGRADATION

Here, land degradation refers to a human-induced or natural process which impairs the capacity of land to function. Soils are the critical component in land degradation when it involves acidification, contamination, desertification, erosion or salination.

While soil acidification is beneficial in the case of alkaline soils, it degrades land when it lowers crop productivity and increases soil vulnerability to contamination and erosion. Soils are often initially acid because their parent materials were acid and initially low in the basic cations (calcium, magnesium, potassium and sodium). Acidification occurs when these elements are removed from the soil profile by normal rainfall or the harvesting of forest or agricultural crops. Soil acidification is accelerated by the use of acid-forming nitrogenous fertilizers and by the effects of acid precipitation.

Soil contamination at low levels is often within soil's capacity to treat and assimilate. Many waste treatment processes rely on this treatment capacity. Exceeding treatment capacity can damage soil biota and limit soil function. Derelict soils occur where industrial contamination or other development activity damages the soil to such a degree that the land cannot be used safely or productively. Remediation of derelict soil uses principles of geology, physics, chemistry and biology to degrade, attenuate, isolate or remove soil contaminants to restore soil functions and values. Techniques include leaching, air sparging, chemical amendments, phytoremediation, bioremediation and natural attenuation.

Desertification is an environmental process of ecosystem degradation in arid and semi-arid regions, often caused by human activity. It is a common misconception that droughts cause desertification. Droughts are common in arid and semiarid lands. Well-managed lands can recover from drought when the rains return. Soil management tools include maintaining soil nutrient and organic matter levels, reduced tillage and increased cover. These practices help to control erosion and maintain productivity during periods when moisture is available. Continued land abuse during droughts, however, increases land degradation. Increased population and livestock pressure on marginal lands accelerates desertification.

Erosion of soil is caused by wind, water, ice and movement in response to gravity. Although the processes may be simultaneous, erosion is distinguished from weathering. Erosion is an intrinsic natural process, but in many places it is increased by human land use. Poor land use practices include deforestation, overgrazing and improper construction activity. Improved management can limit erosion by using techniques like limiting disturbance during construction, avoiding construction during erosion-prone periods, intercepting runoff, terrace-building, use of

erosion-suppressing cover materials, and planting trees or other soil-binding plants.

## DISTRIBUTION OF SOILS IN -CHHATTISGARH

A vast region of Chhattisgarh is covered by red & yellow soil. There are a number of types of soil found in -area but there are four major types namely Kanhar, Matasi, Dorsa and Bhata, which cover major portion of the total land area. The red colour of soil is generally related to unhydrated ferric oxide, and partially hydrated iron oxides. The yellow colour in soil is also due to oxides of iron.

The soils of the region are deficient in important mineral nutrients like nitrogen, phosphorous, lime and potash, which are concentrated in the lower parts of the soil layer. However, the tropical red and yellow soils or the red sandy soils of the region possess texture suitable for growing crops. Data on area under different soil types was available from fifteen areas. We have derived data for the other areas from our maps. For the state as a whole, the predominant soil type is red and yellow loamy Soil. The percolation/water retention capacity, as well as the productive capacity of different soils, varies.

The following types of soils are found in Chhattisgarh:

### Kanhar (clayey)

A low-lying deep bluish black soil with high moisture retention capacity. It is well suited for rabi crops, particularly wheat.

### Matasi (sandy loamy)

This is a yellow sandy soil, with an admixture of clay. It has limited moisture retention capacity. Though used for paddy,

### Dorsa (clay-loam)

This type of soil is intermediate in terms of soil moisture retention between kanhar and matasi. This is best described as loamy, and is a colour between brown and yellow.

### Bhata (laterite)

This soil is a coarse-textured, red sandy-gravelly soil, found on upland tops. It is deficient in minerals and other productivity enhancing nutrients, Gupta and Sinha (1987) [25] observed that in Sarguja, -district most of the soils fell under Orthents (Entisols) followed by Ustalfs (Alfisols) and Ochrepts (Inceptisols). Usterts (Vertisols) were found only in small area.

In Chhattisgarh plains, there is a lot of soil variability in almost every village one can find soils ranging from lateritic (Entisols) to sandy loam (Inceptisols), clay loam (Alisols) and clayey (Vertisols) soils (Anonymous, 1994) [26].

Red and Yellow soils were mainly grouped in four main types viz Kanhar (deep clayey soil with 43-56% clay), Dorsa (Yellow sandy loam soil with 18-29% clay), Matasi (mixture of above soils with medium texture) and



Bhata (reddish yellow gravelly sandy soils of the barren waste lands of the upland region) soils..

## Chapter – II (Past Review)

### PAST REVIEW

A survey of the literature shows that a lot of work has already been done in this area. Thus it provides a clear cut guideline to do the work in a specific direction. The survey of past work is given below:

1. Mueller TG, Hartsock NJ et al. (2001) They were studied, The purpose of this study was to assess the nature and the causes of soil EC variability and to make a first assessment of its potential utility in Kentucky, particularly for fields containing soils derived from limestone residuum overlain by loess.
2. Clay DE, Chang J et al. (2001). They were studied, apparent electrical conductivity contained spatial structure in all fields. Generally, the well-drained soils in the summit areas and the poorly drained soil in the toeslope areas had low and high EC values.
3. Sharma KL, Ram Chandra Raju K, Das SK et al. (2009). They were studied Study revealed that physicochemical properties such as pH, electrical conductivity (EC), cation exchange capacity (CEC), and organic carbon (OC) were significantly influenced by the land-use systems.
4. SJ Officer, A Kravchenko, GA Bollero, KA Sudduth, NR Kitchen, WJ Wiebold, HL Palmand, DG Bullock. (2004). They were studied Measures of soil electrical conductivity (EC) The first soil fertility PC (Soil PC1) consistently grouped together cation exchange capacity (CEC), Ca, Mg, and organic matter (OM). SoilPC1 was well correlated to soil EC for all sites and cokriging with EC had higher  $r^2$  in the crossvariogram models compared to ordinary kriging.
5. Heiniger Ronnie W et al. (2001). This study was initiated to determine if ECa could be used to measure nutrient concentrations in the field. The results indicated that salinity, soil texture, or soil moisture were masking the response of ECa to changing nutrient levels in the soil [31].
6. Humphreys MT, Raun WR, Martin KL, Freeman KW, Johnson GV, Stone ML. (2005). They were studied that soil EC was not better than mid-season normalized difference vegetative index (NDVI), readings at predicting grain yield at any location or year. Combination of soil EC and NDVI was also less correlated with grain yield than NDVI alone.
7. Grant W Thomas. (2006). pH and buffering (reserves) of soils are controlled by a number of soil components such as clay minerals, organic matter, oxides of aluminum and iron and compounds of calcium and sodium. pH reveals the reactions which dominate the soils. As such, pH is very useful as a clue about what must be done to the soil to make it ideal for the purpose we desire. No other single soil measurement gives us so much information so easily.
8. Topp GC, Yanuka M, Zebchuk WD, Zegelin S. (1988). They were studied that EC is an invaluable agricultural

tool that provides spatial information for soil quality assessment and precision agriculture applications including the delineation of site-specific management units.

9. Robbins Charles W. (2001). They were studied, Data from highly weathered, low pH, sodic Australian soils have been used to develop a method for estimating soil exchangeable sodium percentage (ESP) or soil extract sodium adsorption ratio (SAR) from soil pH and electrical conductivity (EC) data.
10. Rhoades JD & Corwin DL. (1990). They were studied model relates bulk soil electrical conductivity (ECa) to volumetric water content ( $\theta_w$ ), electrical conductivity of the soil water (ECW), volumetric content of the solid phase ( $\theta_s$ ) and average electrical conductivity of the soil particles (ECS). Within the model a distinction is made between the water and dissolved salt present in the "immobile"; (fine pores) and "mobile"; (large pores) phases.
11. Corwin Dennis L. They were studied; the measurement of soil salinity is a quantification of the total salts present in the liquid portion of the soil. The measurement of soil salinity is important in agriculture because salinity reduces crop yields by 1) making it more difficult for the plant to extract water; 2) causing specific-ion toxicity; 3) influencing the soil permeability and tilth; and/or 4) upsetting the nutritional balance of plants.
12. Sulewski G. (2001). They were studied Nutrient limiting factor in acidic soils from vegetable fields of the changing suburbs of China.

### OBJECTIVES OF THE WORK

The principles objectives of Soil Analysis was to study the soil at the, the effect of soil analysis of - can give significant improvement in its soil quality. The study therefore provides an opportunity to investigate some aspects such as-acidity & basicity nature of soil, toxic effect of soil, importance of the soil etc.

The main objectives of this study are:-

1. To collect information of soil type, slope, acidity viz. of the soil causes trace element deficiencies, N, P and K deficiencies.
2. To study the physical and chemical properties
3. To know what soil pH & conductivity is and how it is calculated.
4. Crop fertility
5. Understand and analyze the soil quality of -.

### METHODOLOGY

#### Planning of study

Without planning we cannot do our work complete. Planning of study will be done after the preliminary survey of concerned villages (Kawardha). Planning of study include that which area is already researched, which soil fertility is good ,preparation of tools to collect data ,need of time and money, laboratory facility for soil testing.

#### Collection of Soil Samples





Collection of a representative soil samples from the field, which is an outside laboratory activity, is most challenging and difficult task through appears to be the simplest in the face of high heterogeneous nature of the soil.

### Time of Sample Collection

Soil can be tested round the year but summer season is most appropriate for this work. The condition of farms is ideal for sample collection in this season and the results of testing can be obtained before the monsoon crops.

### Study Area and Number of Samples

The study area of the present investigation is located along the soils of the - Kawardha district, Chhattisgarh, India. There are 15 areas are selected from - The soil samples were analyzed for various parameters such as pH, conductivity, organic carbon, potassium, phosphorus etc.

### METHODS OF STUDY

Different type of equipments can be used for sampling. Soil auger tube or knife or Khurpi and polythene bags are used for taking samples. Firstly Divide the field in to area so that each sample represents an area .A sample should be collected separately from areas which differ in soil colour. Clean the site from where soil sample is to be collected by removing undecomposed organic materials, garbage, etc. Scrap away the surface litter and insert sampling tube to a plough depth (above 15 cm) dig a V-shaped hole to a plough depth .Take at least 05 samples randomly distributed over each area in a polythene.

### DETERMINATION OF SOIL

In this study all the collected samples of - were analyzed for, pH , and electrical conductivity to determine O.C.,P,K, in soil. Soil testing is a key to know the soil fertility .The basic objectives of the soil testing programmed is to give farmers a service leading to better soil management practices for increasing agriculture production. Methods for examination of soil sample as below in table.

### DETERMINATION OF SOIL pH [41]

Soil pH is normally measured in a soil water slurry using an electronic pH meter (McLean1982).The present of soluble salts in a soil sample may affect pH ,and for that reason ,some analysis prefer to measure it in a mixture of soil and 0.001 M). The excess salts in this solution masks the effects of differential soluble salt concentration in individual samples .Procedures for each method are given below.

### Soil pH Procedures

The methods for the determination of pH of the soil solution are mainly classified into two groups :

1. Electric pH meter method
2. Calorimetric method.

Electric pH meter method, which is mainly used is being described here.

### Electric pH Meter Method

The instrument commonly used in this method is a glass electrode pH meter with calomel reference electrode introducing salt bridge. Most digital pH meter now a days have single (combined) electrode assembly. The instrument being a potentiometer requires to be calibrated before use with buffer solutions of known pH values.

### Principles

A glass surface in contact with hydrogen ions of the solution under test, acquires an electrical potential which depends on the concentration of H<sup>+</sup> ions. a measure of the electrical potential (emf) is, therefore, give H<sup>+</sup> ion concentration or pH the solution.

### Equipments

1. Glass electrode pH meter
2. Pipettes.
3. Beaker, glass rode.

### Reagents

1. Distilled water.
2. Standard buffer solutions: These may be of pH 4.0, 7.0 or 9.2 in pure water. To prepare buffer solution, in case of buffer tables (available in the market a single to 100 ml. It is necessary to prepare a fresh buffer after every few days. In case a standard buffer is not available, a saturated solution of potassium hydrogen tartarate (AR) may be used which gives a pH of 3.56 at 25<sup>0</sup>C.
3. 0.01 M CaCl<sub>2</sub> pH in soil is determined in following ways:

(a) pH in Saturated Soil Paste

1. Take workable amount of soil
2. Prepare a soil paste by adding small amounts distilled water gradually into soil while working with a spatula.
3. At saturation, the soil paste glistens, flow slightly when the container is tilted, slides freely and cleanly off the spatula.
4. After mixing, allow it to stand with a cover above the container for about four hours.
5. Now see that there should be no free water on the soil surface and also paste should not stiffen markedly or lose its glistening appearance on standing. The saturation paste at this stage is ready to determine pH
6. Remix with water if soil paste loses its shine.
  - a. pH in 1:2 Soil Water Suspension.  
To prepare 1:2 Soil and Calcium Chloride Solution Suspension weigh 40g of soil into a 250 mL Erlenmeyer flask and add 80 mL of distilled water in it. Stopper the



flask and shake the mixture on the reciprocating shaker for one hour

b. pH in 1:2 Soil and Calcium Chloride Solution Suspension.

1. Weigh 10g of air dry soil into a 50 or 100 mL beaker.
2. Add 20 mL of 0.01 M  $\text{CaCl}_2$  solution. It is prepared by dissolving 14.7g  $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$  in 10 L water. Check pH of solution; it should be between 5.0 and 6.5 If required, adjust pH with  $\text{Ca}(\text{OH})_2$  or  $\text{HCl}$
3. Allow soil to absorb  $\text{CaCl}_2$  solution without stirring, then thoroughly stir for 10 seconds using a glass rod.
4. Further stir suspension 4 or 5 times during the next 30 minutes.
5. Allow suspension to settle for 30 minutes.

#### METHOD

1. Take either saturation paste or 1:2 soil water suspension in which pH is to be determined.
2. On the pH meter, set the temperature compensating knob and confirm that the electrode is completely filled with the saturated potassium chloride (KCl) Solution. Allow the pH meter to warm up for 15 minutes to eliminate the asymmetric potential of the instrument.
3. Place known standard buffer solution in a beaker say having pH 7 and immerse both the electrodes and the one electrode (in case combined electrode is provided) into the buffer solution. Electrode should not be touched the wall of the beaker. With the help of the knob adjust the instrument reading at the known pH of the buffer (in this case at pH 7). The buffer is then removed and the electrodes are carefully flushed with distilled water. Now take another buffer solution of known pH say 9.2 [if, reading is not approached 9.2, the instrument is to be readjusted by repeating above procedure]. The second buffer is then removed and electrodes are again flushed with distilled water.
4. The electrodes are then immersed in the beaker containing soil paste or soil water suspension and read pH on the dial and record it on the observation.
5. Remove the electrodes from the soil paste or soil suspension, clean them with distilled water and then dip into a beaker of distilled water. The electrodes are maintained in working condition by keeping them immersed in distilled water.

#### DETERMINATION OF ELECTRICAL CONDUCTIVITY IN SOILS

All soils contain varying amounts of salts in the soluble form as carbonate, bicarbonate, sulphate, nitrate etc. The water soluble salts occurring up to 0.1 percent or more in the soil usually consist of  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$ , and  $\text{Mg}^{2+}$  ions in association with sulphate, chloride, carbonate and bicarbonate ions.

The soil may be Saline and alkaline depending on the nature and quantity as salt percent.

A saline soil is that for which the conductivity of saturation extract is more than 4 millimhos /cm at  $25^{\circ}\text{C}$  and the exchangeable

#### Measurement of Electrical Conductivity

Amount of soluble salts in sample is expressed in terms of the sample's electrical conductivity (EC) and measured by conductivity meter. The instrument consists of an AC salt bridge or electrical resistance bridge and conductivity cell having electrodes coated with platinum black. The instrument is also available as an already calibrated assembly (salt bridge) for giving the conductivity of solutions in millimhos per centimeter or decisiemen per meter at  $25^{\circ}\text{C}$ .

#### Equipments and Reagents

1. Conductivity meter and cell
2. Beaker
3. Standard potassium chloride solution (0.01M) : 0.7456 of dry AR grade KCl is dissolved in freshly prepared double distilled water and made one litre. At  $25^{\circ}\text{C}$  it gives an electrical conductivity of or 1.413 mmhos/cm (dS/m). The instrument is to be calibrated or checked with this solution.

The electrical conductivity of soil commonly measured in saturation extract and 1:2 soil water extract.

##### (a) Saturation Extract

Saturation extract is obtained by extracting saturation paste through vacuum pump. The paste prepared for pH determination can be taken for extraction after determining pH. But for Ec measurement it will be better to know the saturation percentage of soil by knowing percentage moisture content of saturation paste. It will help in further interpretation of results. To know saturation percentage (SP) of soil, the paste may be prepared by taking measured quantity of oven dry soil (200 to 400 gram of soil) and water through burette. Also see in methods of extraction of soluble salts.

$$\text{SP} = \frac{\text{Water content of saturation soil paste}}{\text{Oven dry weight of soil}} \times 100$$

##### (b) 1:2 Soil Water Extract :

This extract is obtained simply by filtering 1:2 Soil Water Extract suspension through Whatman No. 1 filter paper. The 1:2 soil water suspension is prepared as described in pH determination. The filtrate must be cleared, if not, it may again be filtered to obtain a clear filtrate.

Based on the electrical conductivity of 1:2 soil water extract, the salinity of soil may be classified follows.  $<0.8\text{dS/m}$  - No deleterious effect on crop



- 0.8-1.6dS/m - Critical for salt sensitive crops  
 1.6-2.5dS/m - Critical for salt tolerant crops  
 2.5 dS/m - Injurious to most crops

### Method

1. Take saturation extract or 1:2 soil water extract in a 25 ml beaker.
2. Warm-up the instrument for 20 minutes.
3. Use 0.01 M KCl solution to calibrate the meter.
4. Rinse the conductivity cell with distilled water and then with the sample.
5. Rinse the conductivity cell with distilled water and then with the sample.
6. Connect conductivity cell to meter and dip-in the sample. Pass the current and adjust the current by rotating the dial in such a way that maximum sensitivity is obtained.
7. Read the conductivity value in dS/m. Direct reading may be obtained in digital type of meters.

Observed value of EC is multiplied by the cell constant (usually given on conductivity cell) and a temperature factor to express results at 25<sup>0</sup>C if instrument is not provided temperature compensation. Some instruments are provided with temperature compensation in which reading directly comes at 25<sup>0</sup>C. Operating manual must read before operation of instrument.

### DETERMINATION OF PHOPHORUS IN SOIL

Phosphorus in soil ranges from 0.01 to 0.3 percent and occurs in several forms and combinations. The total amount of phosphorus present in soil is not available to the plants, only small fraction of it may be available which is of direct relevance in assessing the phosphorus fertility levels. Commonly used methods for determination of soil is-

#### Bray and Kurtz No 1 Method (1945)

This method is suitable for acid soils having pH around 5.5 or less.

#### Principle

The combination of HCl with NH<sub>4</sub>F which is used as an extractant in the procedure extracts adsorbed and acid soluble phosphorus bound with Al, Fe, and Ca. Phosphate in the extract is determined calorimetrically as phosphomolybdenum blue with ascorbic acid as a reducing agent. The presence of antimony gives a stable Mo-P-Sb complex.

#### Reagents

##### Bray and Kurtz extracting solution

1. The extractant consists of 0.03 N NH<sub>4</sub>F in 0.025N HCl solution. Dissolve 11.1 g of AR grade NH<sub>4</sub>F in 100ml distilled water. Filter the solution. Now add 1 liter distilled water having 20ml concentrate HCl. Dilute the contents of 10 litre. It can be stored for a long time in a polyethylene

bottle.

2. Reagents 2 to 9 and preparation of standard curve are as mentioned in Olsen's method.

### METHOD

- Take gm dry soil in to a 150 ml Erlenmeyer flask.
- Add 50 ml of Bray extracting solution.
- Stopper the flask and shake the suspension for exactly 5 minutes on mechanical shaker.
- Filter the mixture through Whatman No. 42 filter paper. If the filtrate is turbid, quickly filter it again from the same filter paper.
- Take 5 ml aliquot of the extract in a 2 ml volumetric flask. If necessary, add 7.5 ml of 0.8 M boric acid (50 g H<sub>3</sub>BO<sub>3</sub> in 1 liter) to the aliquot to avoid interference of fluoride. Add distilled water to 20 ml and then add 4 ml of Murphy Riley solution.
- Run blank without soil.
- After 15 minutes, read the intensity of blue colour using 730nm on colorimeter or spectrophotometer's. Prior to this, blank may be adjusted on zero of the colorimeter scale.
- With the help of standard curve calculate the quantity of available phosphorus in soil.

### Calculation

$$\text{Bray's P (kg ha}^{-1}\text{)} = C \times \frac{\text{Volume of the extract}}{\text{Volume of aliquot}} \times \frac{1}{\text{Wt. of soil taken}} \times 2.24$$

Where C =  $\mu\text{gP}$  in the aliquot (obtained from the standard curve)

$$= C \times 50/5 \times 1/5 \times 2.24 = C \times 4.48 \text{ [}\mu\text{g P ml}^{-1} \text{ or ppm} \times 2.24 = \text{kg/ha]}$$

### DETERMINATION OF POTTASSIUM IN SOIL

Potash in Indian soils ranges from 0.05 to 3.5 percent out of which 95% part is present in complexes form, 1-10% part in relatively non available form and 2% Part in available form. The term available potassium includes both exchangeable and water soluble forms of the potassium present in soil. The available K (readily exchangeable + water soluble potassium) is usually determined in neutral normal ammonium acetate (1 N CH<sub>3</sub>COONH<sub>4</sub>) extract of soil. To estimate exchangeable potassium, first water soluble K is estimated in a saturation extract and the same is deducted from the ammonium acetate extractable K.

#### Equipment and reagents

1. Flame photometer (Systronic) with K filter
2. Volumetric flask (100 ml)
3. Potassium Chloride standard solution: - Since, concentration of potassium in water and soil water extracts is usually low, the standard solution of K is prepared in ppm or mg/liter. Weigh 191 mg of KCl (AR) salt and dissolve in distilled water. Make the volume up to one liter.



This is 100 ppm or mg/liter K stock solution. For preparing working standard solution of 0, 2,4,6,8 and 10 ppm, pipette same volume in each case into ml volumetric flask and dilute up to the mark.

#### METHOD

1. Read the operation manual of flame photometer. Set the K filter. Start compressor and light the burner of flame photometer. Keep air pressure at 5 lbs and adjust the gas feeder so as to have a blue sharp flame cones.
2. Feed standard potassium solution of the highest value in the standard series (10 ppm K) and adjust the flame photometer to read full value of emission in the scale i.e. 100 reading. Adjust zero reading of the meter by feeding distilled water.
3. Now feed different standard potassium solutions one by one and record the emission value (reading) for each. Plot a standard curve between concentration and reading of standard potassium solution.
4. Take 10 mL extract (aliquot) of sample in a 100 mL volumetric flask dilute it up to the mark by adding distilled water.
5. Feed the diluted extract in flame photometer and note the reading.

If flame photometer does not show reading of unknown, it indicates that the concentration of K in unknown (diluted extract or aliquot) solution is higher and is out of the range of flame photometer scale. In such situation further dilute the extract (unknown solution) and take the reading.

#### Observations

Reading of known Solutions (Standard Solutions)  
: Record the readings of known potassium solutions in the same manner as recorded for sodium.

Take reading of unknown solution suppose it is x.

#### Calculations

Prepare a standard curve between concentration of standard K solutions and flame photometer readings.

Obtain concentration of K (ppm) in unknown solution (in diluted extract) with the help of standard curve, say it is y.  
K (ppm) in water extract = ppm of K as obtained from curve X Dilution factor

$$= y \times \frac{100}{10}$$

Here, volume of extract = 100; Aliquot taken = 10

K me/Litre in water extract = K in ppm/equivalent weight of K (39).

#### DETERMINATION OF ORGANIC CARBON IN SOIL

**Colorimetric method** of estimation (Datta et al., 1962)

##### Reagents

- 1 N (AR grade ) potassium dichromate (49.04 g/l)
- Concentrated sulphuric acid (sp.gr.1.84) with 1.25 g of silver sulphate per 100 ml (not needed if chlorides are absent).
- Sucrose (AR grade) , anhydrous

##### Methods

1. Take 1 gram of soil (passed through 0.2 mm sieve) in a dry 100 ml conical flask (Pyrex / Corning).
2. Add 10 ml of 1 N  $K_2Cr_2O_7$  and swirl a little followed by 20 ml of conc. Sulphuric acid and swirled and keep for 30 minutes on an asbestos sheet .
3. Now the content in the flask is carefully centrifuged to a clear state.
4. The green chromium sulphate colour of the supernatant layer is read in the colorimeter after adjusting the blank solution (without soil) to zero using 660 nm (red) filter.

##### Calculation

Organic carbon (%) = Colorimeter reading (R) x Factor  
(from standard curve)

#### RESULT

Soil Analysis of Selected Area was done in the provided lab. Soils obtained from various different area of Kurud (Dist) were tabulated in table no. 1-15. Result of experimental detail is shown in the table below:

**Table 2. Soil Characters on the basis of Soil types**

SN.	Character	Bhata (entisols)	Matasi (inseptisols)	Dorsa (Alisols)	Kanhar (Vertisols)
1	Slope	Undulating rolling	Level gently undulating	Level gently undulating	Level
2	Colour	Reddish to Dark brown	Yellow	Brownish grey	Dark grey brown to black
3	Texture	Gravelly coarse loamy to sandy	Sandy loam	Slit clay	Clayey
4	Structure	Massive structure less	Angular y	Subangular to angular y	Angular y
5	consistency	Non sticky & non plastic	Slight sticky	Sticky & very plastic	Very sticky & plastic



6	Lime Concentration	Absent	Absent or very low	Present	Abundant
7	Other concentration	Ferruginous gravel	Few iron concentration	Numerous black iron concretions through out	Numerous black iron concretions
8	Reaction with HCl	Non effervescence	Effervescence in last horizon	Effervescence through out	Effervescence through out

**Table 3. Sites and description of Kawardha Dist**

The sampling sites were abbreviated as below :	
SN <sub>1</sub>	= Anwari
SN <sub>2</sub>	= Kulhadi
SN <sub>3</sub>	= Gatapar
SN <sub>4</sub>	= Thuha
SN <sub>5</sub>	= Kodapar

**Table 4. Methods of examination of Soil Sample**

S.N.	Nutrient	Method
1	Soil reaction (pH)	Glass electrode (1:2.5 soil water suspension)
2	Soluble salts (EC)	Conductivity bridge (1:2 soil water extract)
3	Organic Carbon	Colorimetric Method ( Datta et.al.,1962)
4	Available phosphorus	Brays and Kurtz P1 method (1945)
5	Available potassium	Ammonium acetate extract method

**Table 5. Experimental Result**

Sites of Station	pH	E.C. ds/m	Nutrients		
			O.C.kg/ha	Pkg/ha	KKg/ha
SN <sub>1</sub>	5.7	.34	.20	2.50	272
SN <sub>2</sub>	5.6	.07	.22	3.00	75
SN <sub>3</sub>	5.5	.13	.24	4.00	111
SN <sub>4</sub>	5.5	.07	.21	5.00	179
SN <sub>5</sub>	6.0	.05	.25	3.50	168

## DISCUSSION

Details of the same physico - chemical parameters determined in the soil from various sources of the different 5 soil samples are described below.

### pH

The pH values were in the range of low 5.5 to high 6.0 . Minimum pH was observed from Thuha soil and a maximum of high was observed from Kodapar village. The acceptable limit of pH value is between 6.5 to 8.5.

### ELECTRICAL CONDUCTIVITY

Electrical conductivity is a measure of the ability of solution to conduct an electricity. It is related to the amount of conduct an electricity. It is related to the amount of dissolved substance (or ions) in soil solution. It gives an indication of which minerals are present. Changes in conductivity over time may indicate changing soil quality. Soils have at least small amounts of various soluble salts in

them .These salts may be acidic, neutral or basic. They may arise from different sources such as -

1. Primary minerals found in soil and in the exposed rocks of the earth crust and
2. Surface and ground waters.

The EC values were in the range of .05 to 0.34. Minimum EC was .05 observed from Kodapar village, and a maximum of .34 was observed from Anwari village. Beyond this range it will not affect the crop production.

### Organic Carbon

Organic carbon are used to assess the amount of organic matter in soils Increasing soil organic carbon (SOC) can improve soil health and can help to mitigate climate change. Carbon consists of inorganic and organic carbon. The inorganic carbon, present as carbonate or bicarbonate ions, must be removed or quantified prior to the analysis of organic carbon. Once the inorganic carbon



is removed, subsequent analysis of the sample aliquot assumes that all carbon remaining is organic. On the basis of different percentage of organic carbon it can be divided in to low, medium and high .

The organic carbon values were in the range of .20 to .25 Minimum was observed from Anwari village and maximum was observed from Kodapar . The organic carbon was lower in Anawari & high in Kodapar so the organic carbon value is medium effect; beyond this range the soil will affect crop productivity.

## PHOSPHORUS

Phosphorus (P) is an essential element classified as a macronutrient because of the relatively large amounts of P required by plants. Phosphorus is one of the three nutrients generally added to soils in fertilizers. One of the main roles of P in living organisms is in the transfer of energy.

The Phosphorus values were in the range of 2.50 to 5.00. Minimum P was observed from Awari and maximum was observed from Jurda. So the Phosphorus value is low. Beyond this range the soil will affect crop fertility. On the basis of different percentage of phosphorus it can be divided in to low, medium and high.

## Potassium

Potassium (K) is an essential nutrient for plant growth. Because large amounts are absorbed from the root zone in the production of most agronomic crops, it is classified as a macronutrient. Potassium is associated with movement of water, nutrients, and carbohydrates in plant tissue. If K is deficient or not supplied in adequate amounts, growth is stunted and yields are reduced. Some crops exhibit characteristic deficiency symptoms when adequate amounts of K are not available for growth and development. Potassium is mobile in plants and will move from lower to upper leaves. For corn, the margins of the lower leave turn brown. On the basis of different percentage of potassium it can be divided in to low, medium and high.

The Potassium values were in the range of 75 to 272. Minimum k was observed from Kulhadi and maximum K was observed from Anwari.

## CONCLUSION

The summary of present investigation was present given below:

1. There are four types of Soil in - which are Kanhar, Bhata, Matasi & Dorsa. Soil contain various element like N, P, K,  $Al^{3+}$ ,  $Mg^{2+}$  etc.

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2. By analyzing the taken Soil Sample, soil was Loamy Soil, which is also called Matasi, it has mixture of sand, slit and clay.

3. pH & electrical conductivity of soil depends on the basis of mobility of ions and also the importance of soil depends on the basis of pH.

4. By Studying to this soil sample we measure that the productivity of rice, oilyseeds (ground nut, mustard) is best in this area.

5. Maximum Matasi Soil Samples of - have low water retention capacity & low fertility status.

6. The non saline nature of soil is due to the presence of carbonates & bicarbonates of  $Na^+$ ,  $Ca^{2+}$ ,  $Mg^{2+}$ ,  $K^+$  and acidic nature is determined by the presence of chloride or sulphate salts of  $Na^+$ ,  $Mg^{2+}$  etc.

6. High correlation between pH & Conductivity in soil is that pH values affect the conductivity. Conductivity based on salt ion mobility of soil. A decrease in the pH value decreases E.C. or any change in pH value induces a change or variability in the E.C

With the help of this study we find out that the pH value & conductivity of the soil. Moreover we also get to know about the nature of the soil (acidic or basic ) and the type of ions found in it .The measurement of pH value is important because it is helpful in growing crops as they show proper and maximum growth at optimum pH . If the pH of the soil is found to be acidic then in order to neutralize its acidity farmers are advised to use  $CaCO_3$  in their land and if the pH is found to be basic then they are advised for the use of Gypsum for neutralizing the alkalinity of the soil. With the help of conductivity measurement we can find out the amount of soluble salts present in the soil. If it is above 3 then it hampers the process of seed germination as the soil becomes smooth and fine .In order to decrease the amount of salts in soil farmers are advised to have more and more amount of water so that its conductivity would decrease significantly. The pH value also helps to determine the presence of toxic elements present in the soil.

Furthermore it tells about the effect of such element in the fertility of the soil. With the help of conductivity and alkalinity of the soil, presence of some elements and their effect on plant growth .Its increased content in soil produces toxic effect in plants. So we concluded that the pH of this area is mainly below 6.5 to 8.5. This causes soil acidity and low productivity, whereas electrical conductivity of this area is mainly below to 1, which are well within the limit for the normal crop growth and it suggests that soil is not salty.



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