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Relationship characteristics of soil- water and engineering measures for soil-water' conservation also the factors affecting soil

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Abstract
When it comes to agricultural operations or natural resource management, understanding soil water interactions may aid in the judgement procedure. For example, knowing what crops to grow, when to plant those, and when to use certain management methods can help you make better decisions. Understanding these principles is beneficial in resolving both agronomic and policy challenges relating to agricultural water management in the field of agriculture. It is the purpose of this study to provide an overview of the fundamental soil water relationships and to highlight certain engineering solutions that are critical in soil water conservation. It also discusses the elements that influence the soil's ability to keep water in its soil.

Keywords: water, soil, engineering, agriculture, relationship

1. Introduction
The agriculture industry contributes significantly to the Indian economy as a main ingredient of revenue and employment opportunities. Since decades, the Indian economy has been centred on agriculture, and the majority of this economy is powered by the monsoon rains that fall throughout the country. According to World Bank data on Indian agriculture, India accounts for 16 percent of the world's population and has 2.42 percent of the world's land area and 4 percent of the world's water resources. The recommended daily water usage for home purposes is 135-200 litres per person per day. Water use in the mechanization of production is between 135 and 160 gallons per capita per day. Losses and misuse of water resources have resulted in 52-70 litres/day per capita being lost. With a population increase of 1.6 percent, India is expected to have higher water requirements in the future. Consequently, ground water is used for home and agricultural purposes by more than 70% of the world's human population. A sound conservation programme is critical to ensuring that the land remains productive in the future. The foundation of such a programme is soil and water conservation, which also helps to rehabilitate land that has been degraded by erosion and misuse, making it more productive and therefore able to sustain more people. For successful soil and water conservation, we must treat and then use the various types of land in accordance with their capacity and requirement. In order to do this, it is vital to thoroughly understand the land in order to be able to tailor conservation strategies and buildings to the varied types of terrain. These measures can be employed individually on some of the more stable ground, but they are most typically used in conjunction with one another to provide the land more strength, durability, and productivity. Furthermore, they must be employed within the confines of economic constraints and in line with the resources available to farmers. Soil conservation helps to reduce flooding by storing more from the runoff from surplus rainfall in the soil's reservoir for later crop use. By keeping this much water out of streams, soil conservation helps to reduce flooding. In today's world, soil and water conservation measures are being adopted in many nations, resulting in significant benefits for large numbers of people. Agriculturists from all over the world now largely agree that a transition from wasteful to protective and fruitful land use and agricultural practises should be implemented as soon as feasible in order to minimise environmental damage. To put it another way, if individual countries and the globe as a whole are to establish a healthy economy, agricultural production must be increased to levels that are sufficient to feed, clothe, and shelter the population, and provide resources for use in times of disaster. Soil erosion is the most dangerous and widespread illness that affects the earth's surface. Vast swaths of land have been degraded to the point where they can no longer have been used to

grow anything of use to human beings. Because of overuse and bad usage, most of the open land that is still available is in jeopardy. Almost everywhere, population growth is outpacing natural resource availability, putting greater strain on the environment than ever before. Ultimately, the ultimate goal of soil and water conservation is to avoid soil erosion and heal its scars in areas where the erosion has not progressed too far to be remediated by curative measures. This entails, in many cases, altering the uses to which land is placed in order to accomplish this. After all, it has been discovered that the first requirement for land conservation is to match the crop (whether cultivated crops, trees, or grazing plants) to the capabilities of the soils and water available. This is in accordance with the prior statement. Equally crucial is the application of engineering and agronomic methods that, when combined, will regulate and preserve water while also counteracting the erosive effect of both water and wind on the soil and reduce soil erosion.

2. Relationships between Soil and Water

With the underlying principles discussed above in mind, we can now create some fundamental soil water interactions that are vital to consider while managing agricultural operations. The next sections illustrate how the soil parameters indicated above impact the soil water content, soil water potential, and soil hydraulic conductivity of a soil sample collected at various locations.

2.1 Soil Water Content as well as Soil Preservation

The quantity of water stored in the soil at any one moment is referred to as the soil water content, which may be described as either volumetric or gravimetric water content. It is the amount of water contained in one unit of dry soil. Volumetric water content is the most practical way to represent water content for the purpose of constructing a water budget, which will be covered in the next section of this chapter. Gravimetric water content is defined as the amount of water contained in one unit of dry soil mass. When calculating the volumetric water content (percent, unitless), multiply the gravimetric water content (in cm 3 per gramme) by the soil's bulk density to get its % volumetric water content (in grammes per cm 3). When interpreting the soil water content, keep in mind that not all soil water is available to plants for photosynthesis. Known as "plant accessible water," the amount of water available to sustain plant development is defined as the difference among field capacity and the wilting point (fig. 1). The quantity of water that remains in the soil profile after 48-72 hours of free drainage under saturated circumstances is referred to as the field capacity. A third of atmospheric tension is characterised as field capacity, which means that water is kept in the soil only weakly and is readily available for plant absorption when the soil is moist. However, it should be noted that while field capacity is often believed to represent the maximum limit of accessible water, this is not necessarily the case. It is possible for developing plants to make good use of water that has moved below in the soil following a saturation event. Nevertheless, because gravity flow is transitory, this water is often not taken into account in calculations to assess the available water capacity of a soil, although its presence might have an impact on things such as irrigation scheduling. Gravitational water is water that drains freely under the influence of gravity. Depending on the environmental circumstances, gravitational water may or may not be utilised by plants.

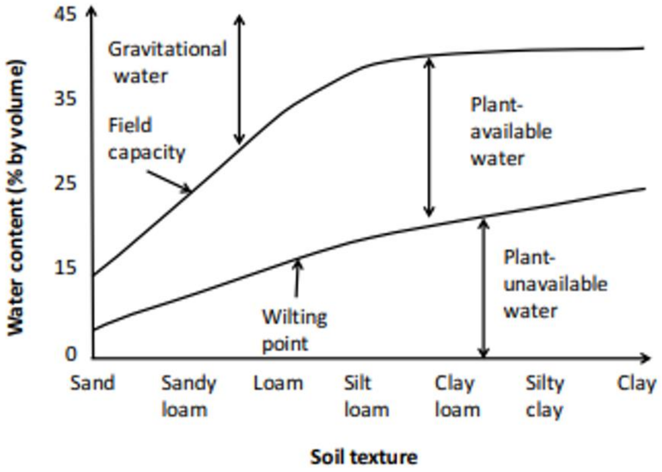

Fig 1: Gravitational, plant-available and plant unavailable water content for various soil textures.

2.2 Soil Water Potential: What More Water Can Soil Retain?

It is important not to mistake the soil water content stated above with the soil water potential, which is the energy condition of the soil water. Solvent extraction (also known as soil water tension) is defined as the amount of labour necessary to move (extract) water from the soil. The tendency of water to flow inside the soil is caused by differences in the potential energy of water from one location in the soil to another site in the soil. Regardless of the potential (energy state) of the water, it always changes from higher to lower potential (energy status), rather than from higher to lower water content. This idea is critical when dealing with non-uniform (layered) soils. Water is drawn into the soil by capillary suction as a result of the adhesion, surface tension, and cohesion at the air/water interface in unsaturated soil pores, causing the water to be retained securely inside the soil. Notably, the capillary suction rises as the size of the hole decreases, which explains why water is held more securely in micropores found in soils with a high clay content. Total water potential comprised of three forces operating on water: gravitational, electrostatic, and magnetic.

Total water potential = matric potential + gravitational potential + pressure potential.

It is dependent on how a unit volume of water is stated that the units of the potential are determined.

Gravitational Potential

The gravitational potential is caused by the force of gravity acting on the water's surface tension. It is not necessary to include soil qualities for determining gravitational potential; instead, simply the vertical distance between the water height and a reference elevation is taken into account.

Aspects of Matric Potential

Matrix potential is caused by the force placed on water by the soil (also known as tension), and it is the result of a mix of adsorptive and capillary forces present in the soil. Known as matric potential, this dynamic feature of soil is virtually zero in a saturated soil and negative at water levels below saturation; matric potential is never positive in a soil. Matric forces are forces that attract and bind water to the surface of soil particles (lowering its potential energy below that of bulk water (water not in direct contact with the soil); that is, it requires energy to overcome the matric force and transport water from one site to another. Capillarity is caused by the surface tension of water and the interaction of the water with the solid soil particles – qualities that are intrinsic to the molecular structure of water. Capillarity is measured in millimetres per second. In extremely dry soils, strong (very negative) matric potentials attach water to soil particles, forming a water-binding network. Due to the greater surface area and smaller pore sizes found in finer textured soils compared to coarser textured soils, matric potential is generally stronger in finer textured soils than coarser textured soils. It is for this reason that clayey soils have a higher plant unavailable water content than sands. This is owing to the adhesive and cohesive forces that exist at the soil-water contact, which cause this effect. As an illustration, in figure 5, the smaller tube has a higher matric potential, which is a mixture of water molecules that adsorb to each other and to the tube walls, than the larger tube.

Pressure Potential

The mechanical or hydrostatic pressure generated by water in a soil results in the development of pressure potential. It is applicable to saturated soils that have a pressure potential. The vertical distance between the sea surface and a particular location is referred to as the pressure potential. In water, the pressure potential is equal to zero above the water level and equal to positive below the water level.

2.3 Classifications of Soil Drainage Systems

Drainage qualities of soils are essential soil attributes that have an influence on a wide range of agricultural productivity characteristics. In the absence of a water shortage, well-drained soils tend to be the most productive; on the other hand, poorly drained soils impede root growth and, as a result, diminish the productivity of agricultural ecosystems (fig. 2). Drought-prone soils, on the other hand, are those that are overly well-drained. Figure 8 displays the five most often used drainage classes, as well as how they relate to the potential productivity of a drainage system. Unlike very poorly drained soils, which are generally depth limited, well- and moderately well-drained soils are frequently not depth limited, allowing roots to fully penetrate the soil and obtain available water and nutrients. Soils with limited drainage are prone to become anaerobic (depleted of oxygen) and decreased in organic matter content (a chemical status favouring certain reactions). A grey look is prevalent in reduced soils; rust coloured iron oxide accumulations are widespread, and they are symptomatic of a changing water table because of the reduction. There are a variety of management practises that can result in a reduced layer, such as over-tillage, which can cause plough pans, or natural causes (such as high water tables and glaciation), which can result in an increased layer of bulk density and restricted drainage, as well as a layer of higher bulk density and increased drainage.

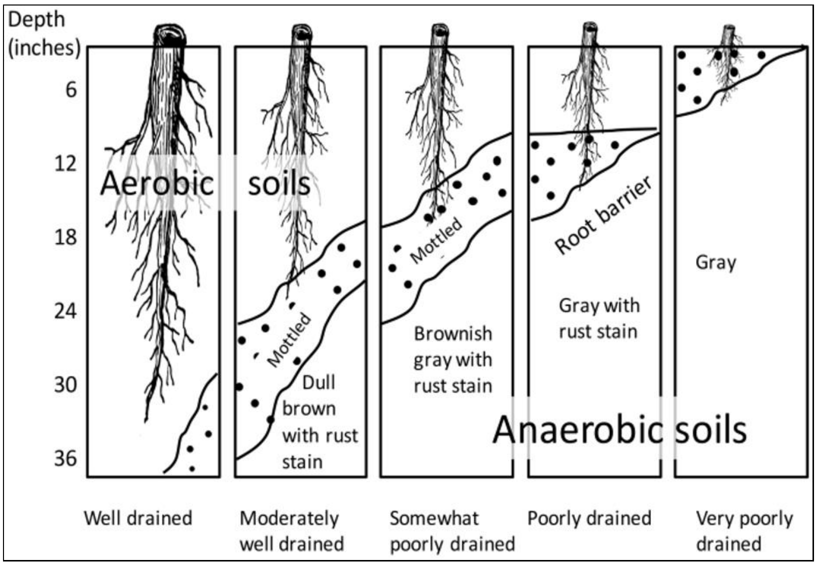

Fig 2: Five widely used soil drainage classes, as well as the depth to which they apply to shallow soils are discussed. Land that is inadequately drained has been subjected to prolonged periods of saturated (anaerobic) conditions, resulting in discolouration of the soil surface and vegetation. When soils are transitioning from aerobic to anaerobic conditions, they may exhibit mottling or colouring that reflects the properties of both aerobic and anaerobic soil conditions.

3. Soil and water conservation measures implemented through engineering.

The aforementioned approaches are employed in order to save soil and water in order to increase agricultural yields: Rainfall, soil, and terrain have all had an impact on the soil erosion process. Controlling soil erosion can be accomplished by the application of proper land management measures. Interventions that minimise soil erosion and hence reduce runoff and save soil moisture can be used to combat the problem. Conservation structures help to retain soil moisture while also trapping sediments. Micronutrients are preserved, and crop yields are increased as a result of this strategy. The method's shortcoming is the generation of huge sediments, which shortens the reservoir's useful life. Gabion boxes can be used to help prevent soil erosion. Stones and wires are used to construct these boxes at the river's edge. On valleys with a steep slope, stone walls were also built to protect the soil.

Dry farming fields can benefit from keeping crop waste in the soil because it contains organic matter that enhances the physio-chemical qualities of the soil as well as increasing the efficiency with which rainfall water is used. In addition to contour farming, which is an excellent way to reduce runoff formation, to retain soil and nutrients, and to optimise the soil physiochemical characteristics to make the most of rainfall in steeper terrain, there is agroforestry, which is another sustainable strategy. The most cost-effective methods of soil and water conservation (SWC) measures have been identified as afforestation, forest fertilisation, and the planting of trees and grass. These methods have been identified as having the greatest potential for achieving the best results against land degradation, environmental, and socio-economic problems in China. Conservation agriculture is a strategy for soil erosion management that is used to increase output while keeping costs down. An additional strategy for soil erosion management, according to the authors, is the use of grass vegetation strips. Water that would otherwise be wasted in the watershed should be collected using a proper water harvesting system. It will improve the quality of groundwater while also providing supplemental irrigation during the dry season. Farmers should be made aware of the need of building agricultural ponds and taking soil protection measures. Appropriate recharge structures and afforestation therapy should be implemented in order to increase groundwater recharge and the majority of plant cover, both of which are important in controlling soil erosion. Solvent erosion may be reduced by using four different strategies. The most successful of them are: closing hill sides for afforestation, planting trees and grass, applying forest fertiliser, and planting fruit trees in orchards. Prioritization of these strategies should be done in accordance with the ecological benefit vs the economic costs in order to maximise the practical conservation investment in the long run. It is essential for plant development and vegetation regeneration in semi-arid environments that soil moisture is maintained at a constant level. Based on the variances in soil moisture for five different land use types, it was determined that the relationship between land use types and soil moisture was complicated. A critical consideration in improving land use and erosion control strategies should be the link between soil moisture and the type of land being worked on.

Land use ineptitude is the root cause of the gullies, which are symptoms of a functional disease of the land. Gully formations, on the other hand, are not the first sign of land abuse. Gully formation is preceded by the erosion of small layers of rich topsoil by water moving across sloping, unprotected ground. Gullies are often a subsequent sign, showing that the land has been abused over an extended period of time. As with human sickness, we can alleviate the symptoms by using a variety of local therapeutic methods. In order to get a permanent cure, we must aim our primary therapy toward the source of the illness—in this example, the entire watershed or area from which water flows into the gully—rather than toward the symptoms of the disorder. The land is covered with grass, bushes, trees, and other vegetation when the circumstances are natural and healthy, as is the case in humid climates. This vegetative cover helps to keep the earth from eroding further. It has the effect of slowing runoff water and causing a significant amount of it to sink into the earth. The water that is absorbed into the earth encourages the growth of new vegetative life. This is a cycle that is good. The soil is exposed to erosion when we disturb this naturally occurring, healthy state by chopping down trees and bushes and ploughing under the grasses. Due to the erosion of topsoil, water will concentrate more quickly in natural channels and form gullies as it travels over the landscape. Less water soaks into the soil, reducing the amount of water available to plants. We run the risk of creating a vicious cycle if we don't come up with other strategies of conserving the land. Gully development occurs as fertile topsoil is being scooped up and taken away by the flow of water. The deposition of profitable topsoil and relatively unproductive subsoil over rich bottom lands is a common occurrence. Apart from destroying productive agricultural land, gullies intrude on and can threaten public infrastructure such as roads, fills, bridges, and culverts. This raises the expense of upkeep and makes travel more dangerous. One of the most common types of land abuse is the cultivation of steep slopes, which is a common occurrence. However, there are other types of erosion as well, such as overgrazing and trampling by cattle (figure 58), which can remove plant cover and generate gullies. The greater the incline of the slope, the greater the risk of land damage. Steep slopes that have been cleared for farming will be heavily gullied in the near future. Gullies are typically formed on the banks of natural watercourses that have been eroded to a significant depth by wind and water. They reach all the way back into the drainage area and become deeper as they climb up the hill to the top. On some cases, waterfalls emerge in the sides of natural depressions as they expand backward and cross lateral drainage ways. In other cases, branch gullies develop when they stretch backward and cross lateral drainage ways. This branching may continue indefinitely until a network of gullies encompasses the entire landscape. The first step in preventing the creation of gullies is to organise the farm in such a way that it makes the most efficient use of all available area. This should involve the conversion of regions that are clearly too steep or too eroded to farm to permanent cover, the use of level or gently sloping terrain for cultivated crops, and the planting of close-growing perennial vegetation in natural depressions or streams. One of the most well-known means of regulating or avoiding erosion is the use of vegetative controls such as grass, grass and legume mixes, and combinations of vegetative and engineering controls, among other things. Engineered controls, such as contour cultivation, cover crops and crop rotations, and contour strip-cropping, which can be used alone or in combination with terracing where it is necessary, as well as the use of meadow outlets for terrace-water disposal, can be used to support these management strategies and prevent soil erosion.

4. Variables that have an impact on water holding soil capacity

It is energy-related phenomenon that water is retained and moved in soils, that it is taken up and translocated in plants, and that it is lost to the atmosphere. The evaporation of water from the soil surface and the transpiration of water from the leaf surface are the two main mechanisms by which soil water is lost as vapour. During a crop growth season, the cumulative loss resulting from these two processes is referred to as evapotranspiration, and it is responsible for the majority of the water removal from the soil. A variety of factors influence the proportional losses from of the soil surface and through transpiration, including:

(a) the proportion of plant cover to the soil surface,
(b) the efficiency with which various plants utilise water,
(c) the proportion of time the crop is on the land, and
(d) The climate.

The amount of water lost by evaporation from the soil is proportionally larger in drier regions than in humid locations in most cases. In dryland locations, such vapour loss accounts for at least 60 percent of total rainfall, with transpiration losses accounting for around 35 percent, left approximately 5 percent for runoff. It is also important to note that hydraulic conductivity and cation exchange capacity have an impact on the water retention capacity of soils. Two key elements influence the stream of fluid in saturated soil: the hydraulic force that propels the water through the soil and hydraulic conductivity, which refers to the ease with which soil pores allow water to travel through them. The soil's ability to store positively charged cations is a determinant of its cation exchange capacity. The greater the number of Cation exchange capacity units, the greater the amount of nutrients and water that the soil can store.

5. Conclusion
Soil and water are most precious natural resources on the planet, and they are also the most vital for human survival in the long run. India encompasses around 2.4 percent of the world's land area and is home to approximately 16 percent of the world's human population. As the world's population grows and water resources become more restricted, timely irrigation with the appropriate quantity of water becomes increasingly important in order to reap the greatest possible advantage from the limited supply of water. In irrigation scheduling, the actual time or stage of the crop at which irrigation should be administered in order to restore the soil water previously eaten by plants before they are adversely impacted by a lack of water is referred to as the crop stage. There are several other soil and water conservation methods, such as avoiding gullies, terrace cropping, and rainwater collection, that are recognized.

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