Water Management
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Lecture 02
Soil, Water, Plant Relationships

Today we are going to talk about the topic on soil, water and plant relationships. We have in the last topic discussed on various basic aspects of irrigation water management.

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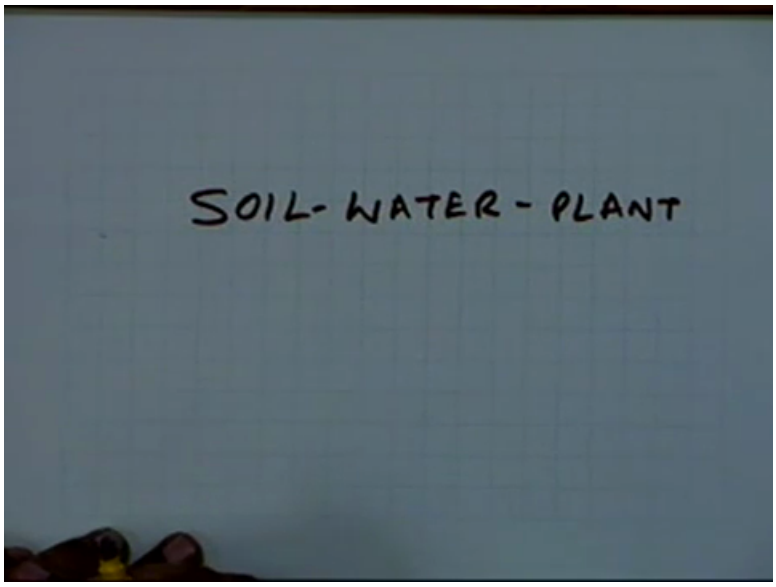

When you talk of irrigation water management we must start with the understanding of soil, water and plant relationships because soil is a medium which is used to store the moisture which in turn used by the (pl) plant. So it is the relationship which is very essential to be understood if we really want to make use of the water resources available to us in a most (()) (02:46) manner. First of all we will like to look into the various properties of the soil which are important from the point of the crop production.

And the first in these properties is the soil composition which has its own importance. What do we mean by the soil composition? As we know the soil is made up of these various elements. The soil contains mineral particles, it can contain organic particles, it has the pores and can also have living material. The mineral particles basically they are the basic parent rock which has degraded over the time and it has disintegrated to create these particles and that forms one of the basic constant of the soil composition.

Then the soil can also contain organic particles. These organic particles are the residuals of plants or of animals at different levels of (())(04:51) and these organic particles plays an important role in different manners in the sense that the composition of soil if the organic particles are there it can help in the chemical reactions, it can help in the storage of water. And then the pores are another important aspect of soil. The pores can either be filled up by water or by the air.

These pores spaces play a very important role in terms of providing the minerals which are dissolved in the water which is available in the pore spaces and also providing aeration to the plant through their root system. Then the plant can also have living materials. They can be worms, they can be and the roots are also they can be called as living material. And these living materials again they have an important role to play.

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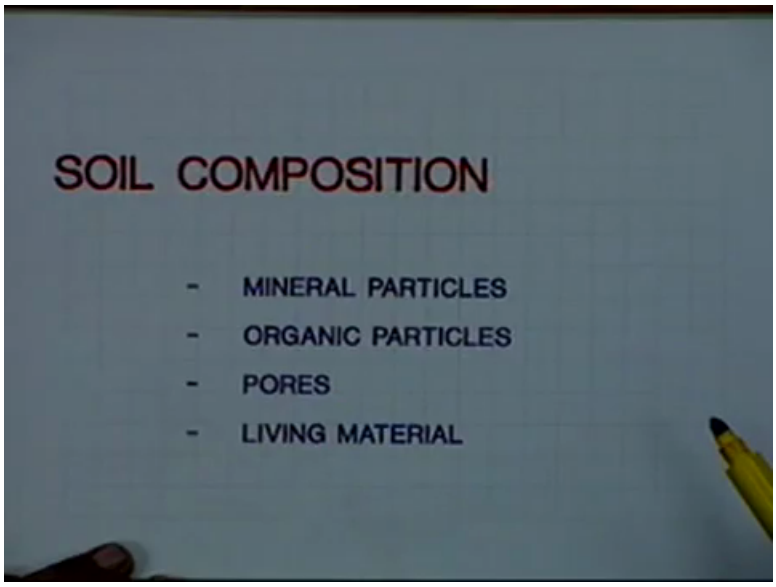

So all these things put together when you look at the soil and their constants then you try to understand the composition in terms of their storage of water, in terms of their availability of water because ultimately the soil matrix is going to support the plant. So from that angle it is very desirable that we must have a proper understanding of the soil composition. At this juncture I think we should also understand that the soil composition is something which cannot be changed by the farmer.

It is something which cannot be altered by the farmer. It is something which is a characteristic of the area of the land in question. To have a look at the soil matrix from the point of view of the composition here we have tried to depict the soil particle and these are

the pore spaces. Now the pore spaces are having (com) combination of water and air. And one more thing that the percentage of water or air which is available in the pore space, that normally remains fixed.

If the percentage of water goes up it will be at the cost of the air. The air can be replaced by the water and there can be a situation where if the water is used by the root system then there can be more air in the same pore space. So if one decreases the other increases or if the other one increases the previous one will decrease. And the level of pore spaces remains same. We will also look at the other properties which are important from the point of agricultural practices and from the point of your storage of water.

But at this juncture it is also important to understand that this matrix of soil, the way the water and the air is available and the way the amount of water which can be made available to the plant root system, there are some other properties which influence that aspect. The water which is available inside is available in the form of or is being acted upon by some forces which we will very shortly come to those properties also which are influencing the availability of this water.

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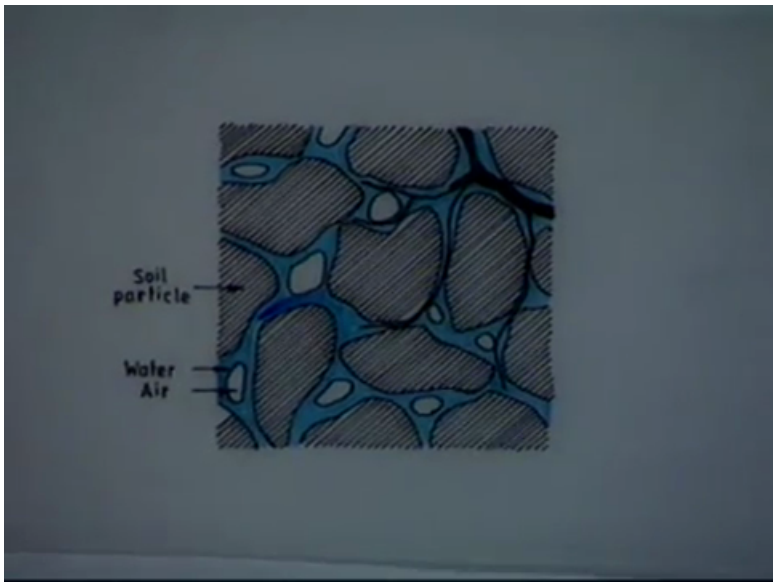

There is another term which you will very often come across which is soil profile. What do we mean by soil profile? If you look at any soil and try to dig out the soil at a particular point may be up to the depth of around 2 to 3 metres you will find that in general the soil will be made up of various layers. Now these layers can also be sometimes you term them as horizons.

These various layers have different characteristics. In general you will find that typically these layers can be classified into these different layers. They can be plough layer, deep plough layer, subsoil layer and parent rock layer.

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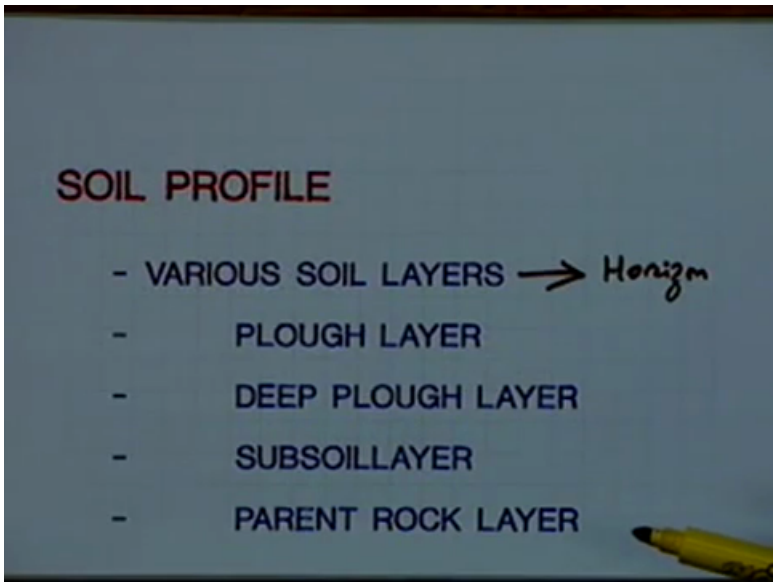

Depicting that you can have a look at this figure which shows these typical layers. The top layer which specifically supports the growth of plants, the root system of plants is normally supported by the plough layer. This is the layer where the extent of this layer can be around 30 centimetres or so or maybe slightly more. And most of the cultivation activity is confined to this plough layer and this is in comparison to the lower layers this is having more of organic matter.

The deep plough layer is the one which is supporting the deep root systems of trees and the subsoil layer is a layer which normally does not support any root system. Maybe some of the roots might be penetrating to the subsoil layers but invariably this layer will be having more of moisture availability. This will be the layer which will be saturated layer.

And then this follows the parent rock layer which is having the lowest level of the soil or the organic matter also will not be available in this layer. And that is the layer which is representing the parent rock from where the top layers have been formulated over the period of time.

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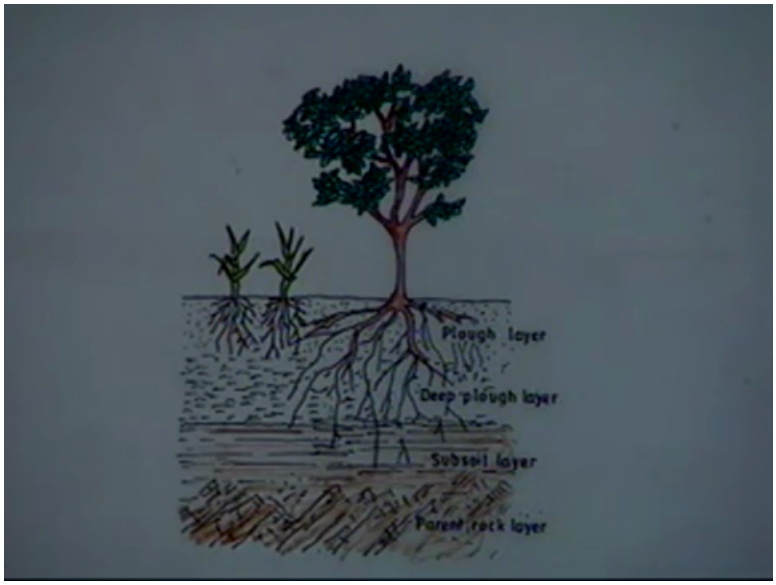

So when we talk of the soil profile is very desirable to know how the profile is or the characteristics of the profile. How the profile varies from the top layer to the parent rock layer because these layers are going to influence the availability of the moisture as well as the flow of water which is either being made available through the natural rainfall or through the artificial irrigation. Coming to another very important soil property which influences the moisture availability or the moisture movement is the soil texture.

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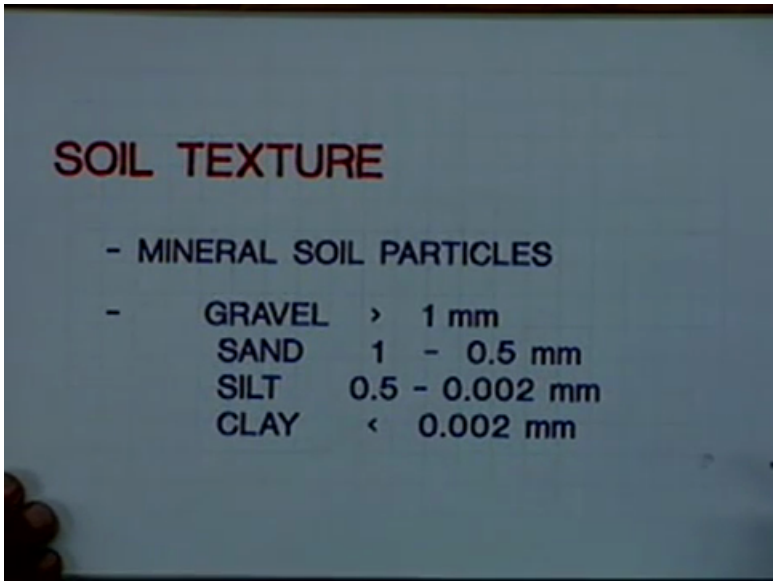

We all know that there are mineral soil particles which formulate the soil. These particles can be subdivided into different classes with respect to their sizes. There are many different classifications of soil which are available in literature and in some cases even these ranges

there can be some variation in the sizes which are presented here. But in general they do not very much. For example the gravel is one of the mineral soil particles. If the size of that particle is more than 1 millimetre it is coming to the class of gravel.

The sand varies from 1 to point 5 millimetre size particles. If the particle size is between point 5 to point 002 millimetres then it is termed as silt. Anything below point 002 millimetres is clay. Now when we look at the soil, the soil will be having these proportions of the different soil particles and the proportion can vary. With the variation of those proportions the characteristics of the soil in terms of the moisture availability and the moisture flow they are going to be influenced.

So it is important to know those characteristics and it is important to know those classifications which have been put (for) forward in literature. And we can later on use those properties in terms of knowing our soils better. So in that intention the soil texture is having its own importance. And let me give you at least one textural classification which is given by US Department of Agriculture. Now with respect to their classification clay is up to point 002.

Anything less than point 002 millimetres is termed as clay. Silt is point 05 and less or between point 002 and point 05. And the gravel as I have just mentioned is anything greater than 2 point 0 millimetres. Now as far as the sand is concerned it is sub classified into five different varieties. Very fine sand, fine sand, medium sand, coarse sand and very coarse sand. And their sizes vary in this manner. This is one typical textural classification.

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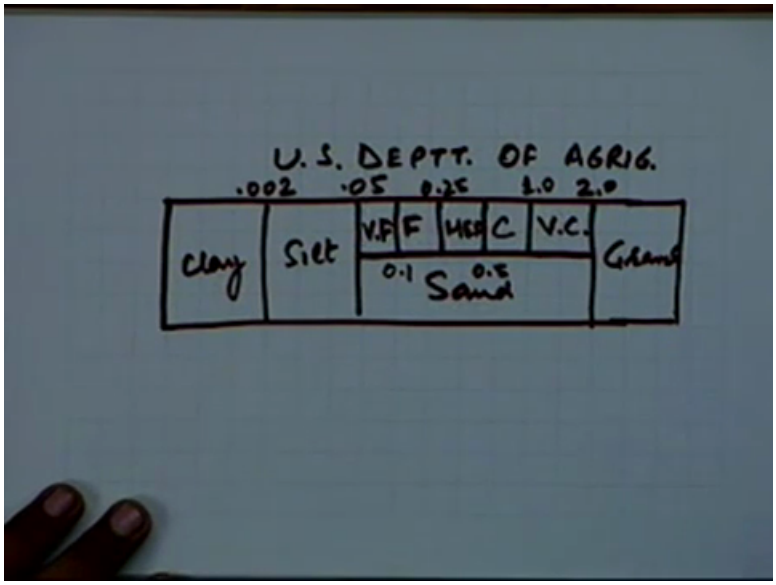

However another classification if I extend the same thing, Atterberg gave another classification which had the same size as far as clay is concerned, it have the same size as far as gravel is concerned but gave a different size for silt. Silt as per his classification was only between point 002 to point 02 and the sand he only subdivided into two subcomponents, fine sand and coarse sand. And the demarcation between fine sand and coarse sand was the size of point 2 millimetres.

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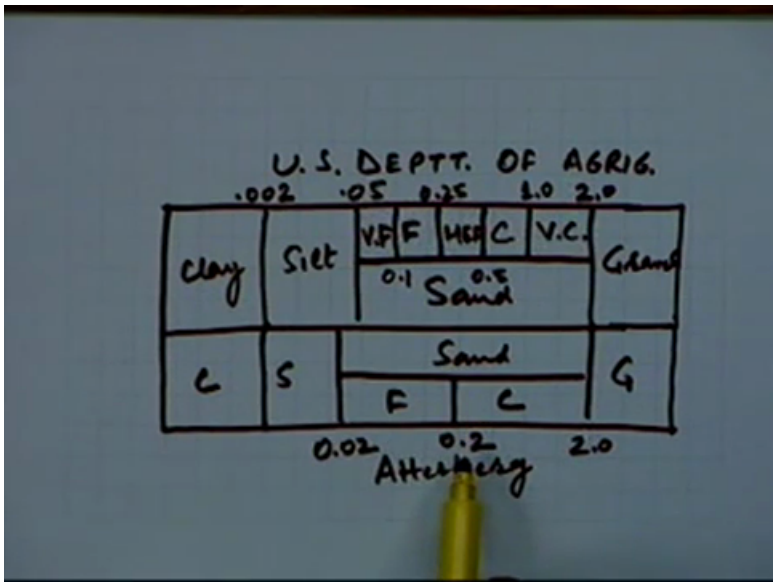

Now this is more simple a classification and there are many more complicated classifications. Later on the US Department of Agriculture came out with you can say a much more diversified classification which had the soil classes divided into 12 different subgroups. Now it is a function of how refined your study is going to be? What are the various parameters which you are going to consider? How much variation of various properties you are going to expect and what is their importance?

You can go in for a very complicated classification provided you have sufficient data. But in general most of the time you will find that broad classifications which are just sufficient to give you reasonably good information on the changing of or the change of basic properties of soil from the point of your after absorption of soil moisture and the release of the soil moisture or the way they let the moisture flow out of their structure, that is what is going to be important.

So from that angle even if you know the classifications or you consider them in the most general manner which are reasonably sufficient to take care of your interest, these three

textural (quail) classifications are quite sufficient and these are coarse textured soils, medium textured soils and fine textured soils.

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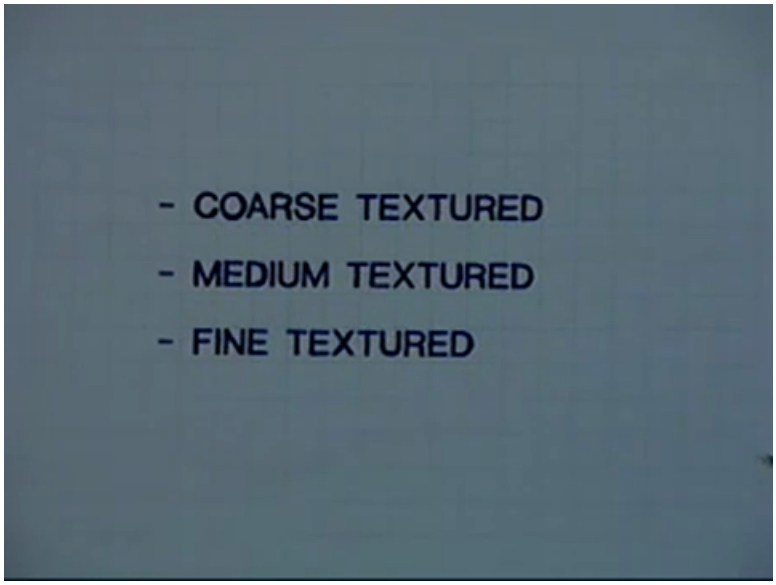

These soils from these three classifications they are different names given. The coarse textured soils are the ones which are predominantly having more sand component so they are sand predominant soils. They are also sometimes termed as sandy or light soils. The medium textured soils are more silt predominant and they can be also termed as the loamy or medium soils. And fine textured soils are clay predominant and they are also termed as clay or heavy soils.

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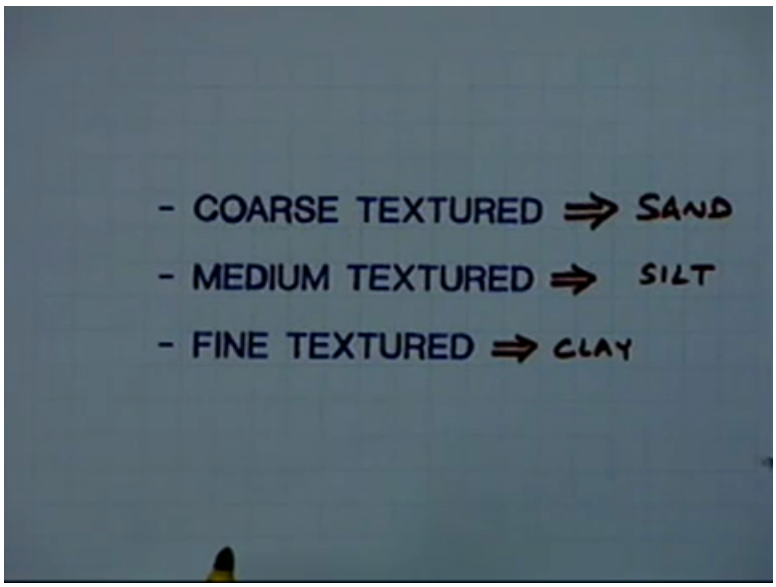

In general at this juncture we can say that some of the properties from the angle of our agricultural activities, the coarse texture soils are the ones which let the water move through them at a very fast rate in comparison to the fine textured soils where the rate of movement will be very slow. If you just try to look at the typical situation where you have two soils. Let me say that this is loamy soil and is sandy loam to be precise. In comparison we have another soil which is again a loamy soil but is clay loam.

Now if you try to make the water available at top the way the water will move will have a movement of water in the sandy loam in a manner which is much faster. Let me say this is 15 minutes, this is after 40 minutes, may be this is after 1 hour. And in comparison in the clay loam soil you will have a spread which is much slower in the downward direction. Maybe for the water to reach this place it might take around 4 hours and for the water to penetrate up to this depth it might take much more time may be up to around 24 hours.

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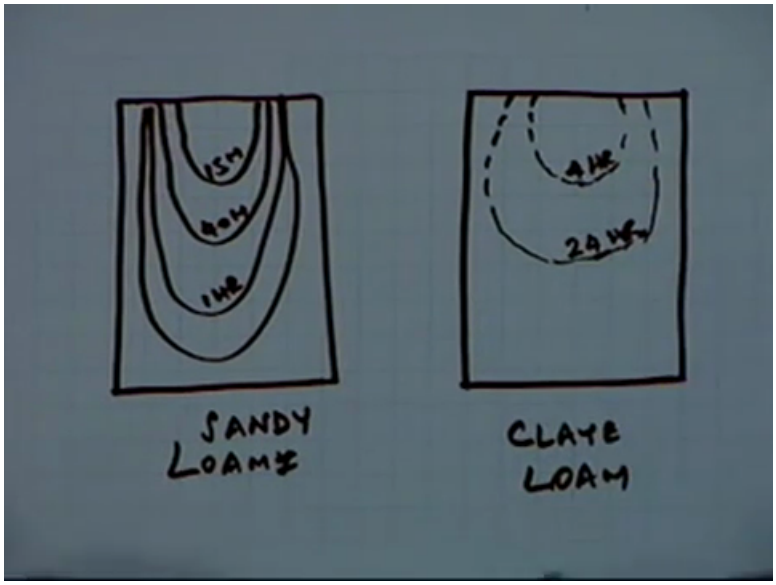

So that is the level of difference between the two. Though the spread will be much better in the case of clay soil which is having clay predominance in comparison to the sandy loam, the sandy loam will have more movement in the vertical direction. Then soil structure is another aspect of soil which gives us more insight into another property of soil which deals with the movement of moisture through the soil. But first of all it is important to know what do we mean by soil structure?

It is the soil structure refers to the arrangement of soil particles. We have talked about the different soil particles. How those soil particles are arranged and they make a compound of

the soil. That is what is known as the soil structure. So if you look at a group of soil particles you can call it as soil aggregate and the soil will be composed of many of such aggregates. And these aggregates, their position in the soil, how they are structured, how they are placed, that is what is going to decide the soil structure, okay.

Now the soil structure is something which can be altered. Earlier we had said that the soil constants they cannot be altered whereas the soil structure because soil structure is something which is the structuring of the soil, which is the placement of the soil particles or the aggregates and that can be altered through the farming activities.

So the farmer can afford to alter these structures of the soil and he can try to get that structure which is more beneficial for his agricultural activities. What are the various arrangements of aggregates which are normally found in the soils? These are granular structure, blocky structure or the blocky arrangement of aggregates, prismatic and massive.

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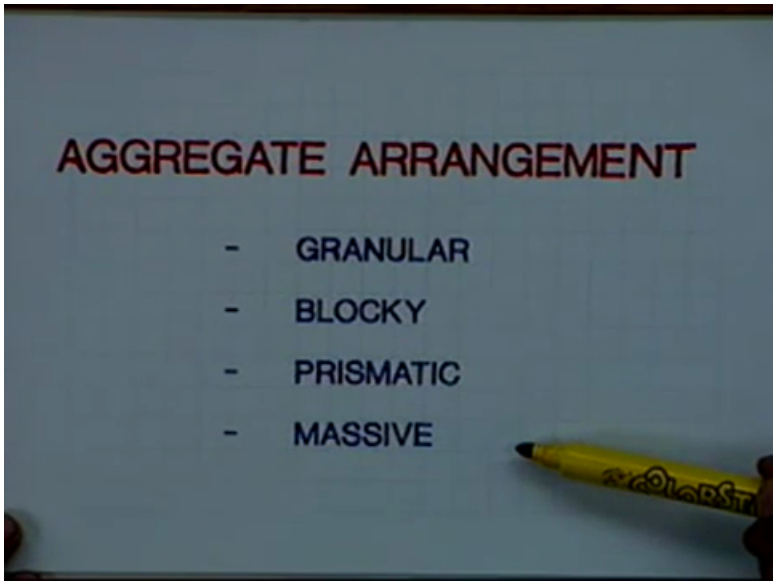

These arrangements they influence the movement of the moisture. For example in the case of granular structure you will find that the moisture will be moving at a very rapid rate. On the (co) contrary if the structure is massive then the rate will be very slow. Now between the two structures in one case the placement of the particles will be such, the placement of the aggregates will be such that there are more pore spaces.

The pore spaces are allowing the water to move through their spaces whereas in the case of the massive structure the placement is such that the pores are not in a position to let the moisture move out of that structure.

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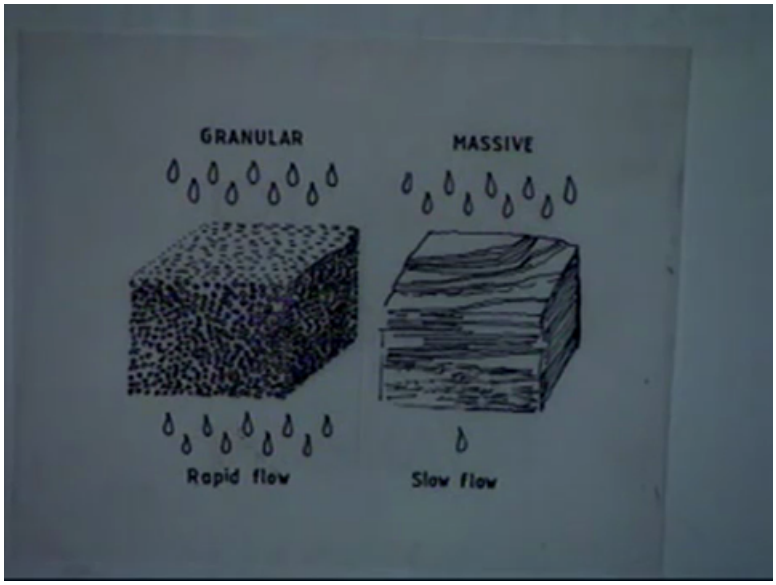

Whereas the other two structures the blocky and the prismatic they have a moderate rate of flow through them and the structure from this angle it makes lot of difference in terms of the movement of the moisture and even the other agricultural activities. For example if the structure is such that it has the pore spaces connected to the moisture available in the soil at some lower depths that can enhance the evaporation activity from the soil.

So to break those capillaries, to break those connecting pores you can change you can alter the structure. You can do some killing operations and that can reduce the loss of moisture through the evaporation.

So if one has the understanding, if the farmer knows about what are the various properties and how they are influencing the different processes of the moisture storage or moisture movement then he can take the appropriate steps to ensure that those actions can be taken which are more beneficial, which are more judicious from the water management point of view.

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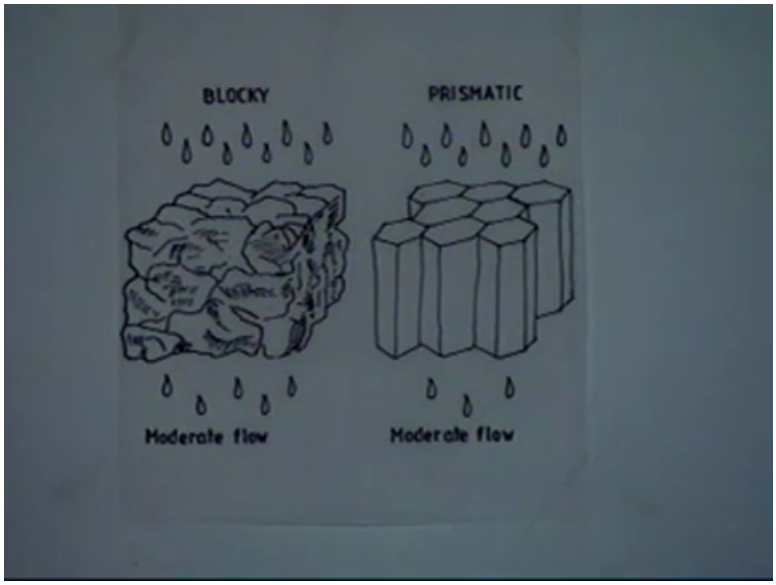

Next we will talk in terms of infiltration. First of all what do we understand by the infiltration process? The infiltration is the process of the water entering into the soil. So it is the process of the moisture entry into the soil and its subsequent movement into the soil of this water which has entered into the soil is known as percolation. That is how these two processes are different from each other.

But infiltration process is more important because if we understand this process in a proper perspective we can ensure a proper storage of moisture into the soil because if the water cannot enter the soil, it cannot be stored into the soil. There might be a situation where you have applied the water onto the surface of the field and most of it has run off the field, it has not been able to penetrate into the soil. That is where the infiltration process is having its importance.

We must understand what are the various factors which govern this process of infiltration or which influence this process of infiltration? The infiltration rate, before I go further I think I must try to tell you that infiltration can be expressed in many ways. It can be expressed in terms of rate in which case its units are depth per unit time, okay. Or it can be just expressed in the form of depth in which case it is accumulative depth and that again it is with respect to that depth over how much time.

So in that case you are not looking at the variation of this infiltration in time, you are only interested in the final outcome which is only the accumulated depth that over the last so many

hours how much of the depth you could accumulate into the soil? That is what will be the infatuation depth.

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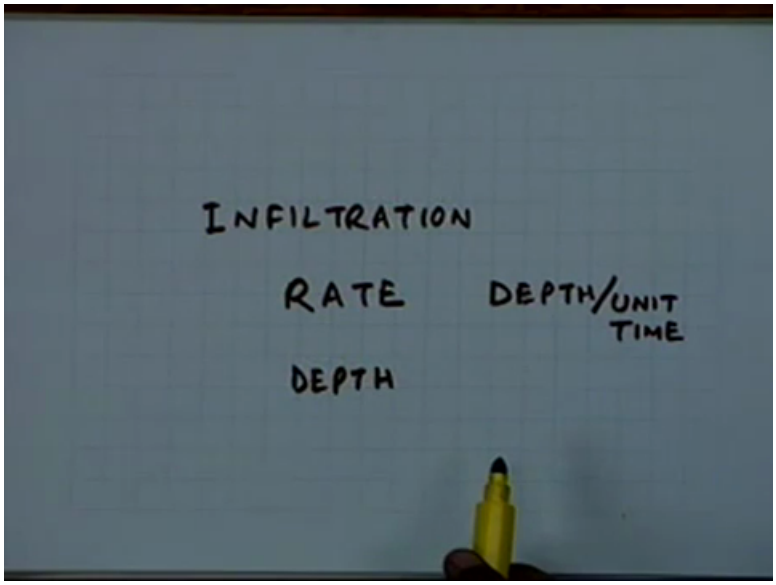

When you talk of infiltration rate, the rate is something which is dependent on many factors and the major factors which influence the infiltration rate are soil texture, soil moisture content and soil structure.

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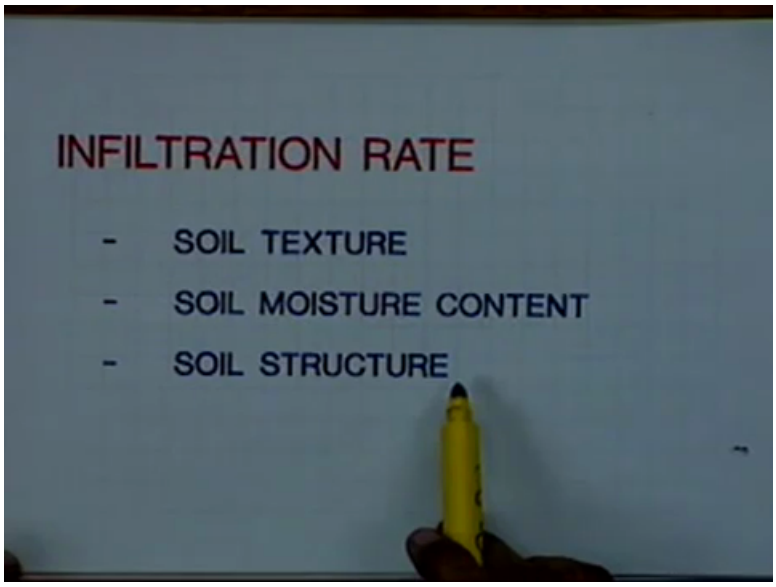

I think we will stop here.