Fundamentals of Environmental Pollution and Control
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Lecture No. # 23
Soil Acidity

The parameters of soil which are important for vegetative growth, particularly two things are important for us. One is that you know germination of the seed. The first of all the most important thing is that the seed is able to germinate in the soil that means it will have sufficient amount of air in the soil, water, temperature and other you know nutrients that would make it to germinate, the seed would germinate first. Once the seed germinates, the next term thing is the growth of the plant and stabilization of the plant in the soil medium, in the soil medium. So, we were discussing about what are the parameters that actually influence, this actually influence this, the total soil growth, total plant growth in the soil.

Now, we have discussed a number of parameters we have you know you in the course of last two classes. Another very important parameter which is a either is basically a part of which we have already discussed you know because you know soil acidity would be a combined effect soil acidity or soil alkalinity is a combined effect of the vegetative say total organic matter in the soil, total salt present in the soil, the different the characteristic of the soil, soil structure all this combine together to form soil acidity or soil alkalinity but there is a, the combined effect is very important for us because you know this would deal with you know we would, this would be an important parameter for the seed germination and plant growth.

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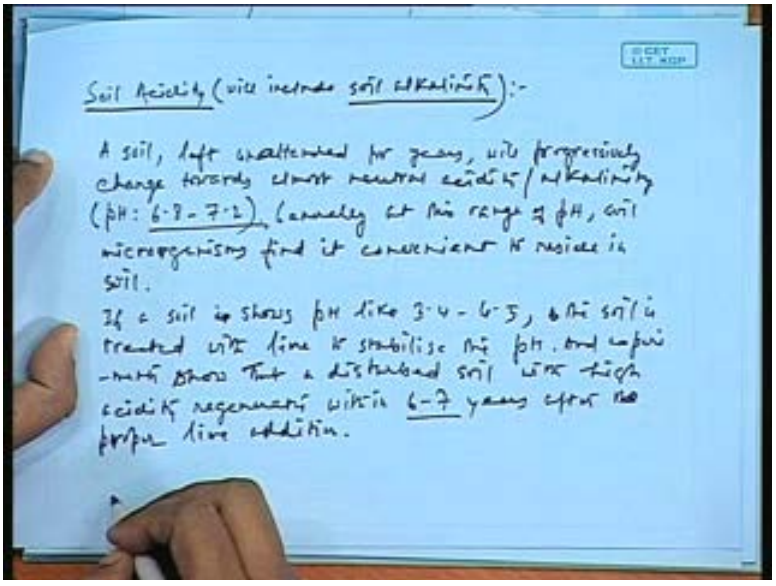

So, here having to say that you know this what we generally observe is we generally start with soil, soil say acidity just to say this, this is you know also would mean include, will include soil alkalinity, soil alkalinity.

So, here itself you know we just can say this, so the mostly, so here you know when we are discussing about this soil acidity is the important part is that it also includes soil alkalinity, I mean you say just to mention that the soil acidity also includes soil alkalinity. Now generally as you know, you know generally a soil, a soil left, left unattended for years, for years will progressively, will progressively change, will progressively change towards almost neutral acidity or alkalinity, right towards neutral acidity is say so you can find out if the soil is unhindered or the soil is not disturbed for a long time, we will generally observe the soil pH would be between 6.1 to 7.2 about this. So, you know you can see it is neither very acidic nor very alkaline. So, this is what you know the soil would progressively move towards, the soil would progressively move towards, in effect you know generally, generally at this, at this range of pH, pH the soil microorganisms will deal with them also at this, at this range of pH soil microorganisms find it convenient, find it convenient to reside in soil, in soil. We would also see this, we'll try to observe this you know how actually this things, this thing is related.

As you saw generally in a, in a it's not so, here with the well… Another important thing is you know related to this you know you say a standard if a soil is soil shows pH like, pH like 3.4 to say above 4.5 which is quite acidic. The soil is or is treated with lime, treated with lime to stabilize the pH and experiments show, experiments show that a disturbed soil with high acidity, a disturbed soil with high acidity, disturbed soil with high acidity regenerates within 6 to 7 years after proper lime addition, the proper lime addition. So, here you know we would try to see now is generally say the lime addition. See, this you know effect of soil acidity, so we will just see you know this is, this is just a, just to show you know the effect of say how you can bring down this is just to suggest see you know lime is a very important element, lime is a very important compound that are used for different you know kind of environmental remediation. As you have studied you know in the case of water, also in the case of soil lime is a very important material to use any kind of you know soil reclamation problem its generally starts with the lime addition okay.

So, if you do not know much about the soil and if you have seen the soil conditions you know not very good, you know you find it somewhat acidic or being run by some acidic water or things like that, the first thing one should do, try to do is to add lime so that the soil becomes somewhat stabilized. And this is what you know this is just to suggest that, that is what I meant is you know there are many other material that are generally also used but the lime is one to start with, lime is one to start with so okay. So, if you could not write down that you know we can still take it down, if a soil shows pH like 3.4 to 4.5, the soil is treated with lime to stabilize the pH and experiment show that a disturbed soil with high acidity regenerates within 6 to 7 years after proper lime addition, after proper lime addition. This is quantity of the lime has to be found out that is what I mean by proper lime addition. You must provide adequate amount of lime to regenerate the soil okay.

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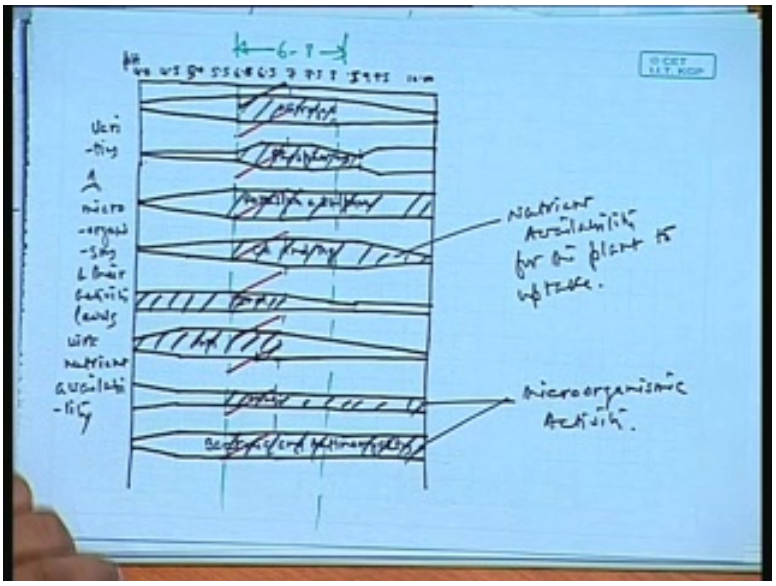

Having said this you know there is one important figure that we can draw is you know if we just see this you know let us make a drawing of this you know it would be clear to you now. We can this, this is you know this is about say pH and we start about say about 4, we say 4, 4.5 say four point say five, 5 then 5.5 then 6.5 sorry 5, 6, 6.5 right 6.5 and then 7 though we can find out 7.5, 8 then you know 0.5, 8.5, 8.5 then you say it is about 9, 9. So, 9 then 9.5, 9.5 and say 10, so on. So, you can see, you can graduate this you know according to this 4, 4.5, 5.0, 5.5, 6, 6, 6.5, 7. So, this is, this is the point where the soil is neutral okay. You can see this effect now, 10, we just say go about till 10 here okay, 10, 7.5, 8, 8.5, 9, 9.5, 9.5 and 10. So, this one is 9.5 and 10 okay. Now, having to see this you know if we just try to see how this, all this micro this, all this organisms essentially it stay in this say here it is the varieties of, varieties of micro microorganisms and their activity, varieties of microorganisms and their activity levels, okay. So, here you can see this, this is what varieties of microorganisms and microorganisms and their levels addition to that with nutrient availability.

We have discussed about the nutrients, soil nutrient in the last class. What it means is that at different pH, the nutrient availability in the soil changes, at different pH the nutrient availability in the soil changes say you know something like this say let me explain this. Say, you know here say is for nitrogen, nitrogen if you just absorb nitrogen in soil, nitrogen in soil would be here about like this. You know this would be this is what you know you can just absorbs nitrogen like this. This is 6 and then 6 to about 8, nitrogen levels in soil would almost remain constant but it would go down as you can see that you know have here as such if you just make this as 10, if you just bring it down to 10 like this right here we can see that at 10, at 10 the nitrogen would be lowest again. What it means is you can see this from this plot here that the nitrogen would go down in the soil. If the soil pH reduces further from 6, the soil nitrogen reduces. On the other hand, from the other side if you see for more than 8, more than 8 starting from say 8.5 say at 8.5 it would begin to go down. So, what is at, you now if you are reclamation engineer suppose you know you are in the work of environmental remediation in the field. So, you should attempt to have the soil pH to be remaining within 6 to 8.

So, this would be our objective, this would be our objective only then you can supply sufficient nitrogen to the plant. So, this is what you know this is about nitrogen, nitrogen. You just see this about interestingly for say there is another important aspect of this you know if you can just see this, this is for, this is for phosphorus. Phosphorus seems to be somewhat more sensitive, phosphorus seems to be somewhat more sensitive and it can only remain, it can only remain at high level, it means 6.5 and 7.5 and then, and then it would go down generally observes you know it shows a plot like this, it shows a plot like this whereby say about 8.5, say about 8.5 it shows like this say from again, again from say 8.5 onwards say about from here I just made, you just make a correction here say 8.5, this one is 8, 8.5 okay, 8.5 I think I made a mistake somewhere. Anyway the plot is like this, so here itself we can see this.

So, you can see this, the idea of this is at low pH, at low pH phosphorus becomes, phosphorus certainly going out of the soil, phosphorous going out of the soil. So, the ideal condition, ideal condition for this you can see this ideal situation for nitrogen is this where the nitrogen should be kept. See here itself it says for phosphorus, this is phosphorus you should try to keep about this much, you just try to understand it's not important that only phosphorus would do. See while we are trying to keep phosphorus you should also try to keep nitrogen, the soil should not be unnecessarily enriched with phosphorus. So, we know we should not try to keep the, we should not try to make the value of phosphorus high in the soil. So, you know this is the ideal value you know at which you should work on, at which we work on, if we just want to keep say there are becomes substances like this. So, here again you know if this is the value for the phosphorus, phosphorus generally is you know is remain almost unaffected, almost unaffected till about, till about 6.

This is potassium and sulphur, this is phosphorus, potassium and sulphur, potassium and sulphur, potassium and sulphur. This one is as I have said phosphorus. So, here again as you can see we would be very safe if we can keep the pH between say 6 to 8 if we are pretty safe, if we are keeping pH at 6 to 8, on the other hand just try to see this, say this about potassium and sulphur on the other hand this calcium in see if you just observe calcium, calcium at, calcium shows a characteristics like this, calcium and magnesium. So, you can see this calcium and magnesium being here then we have iron which is like this, which is like this, the iron, this iron would be about okay. So, iron is… Now there are many other you know manganese okay let me draw the manganese one the manganese stage like this manganese is like this whereas this one is… So, this is manganese, there are few more, there are few more I am not going to that but you can see what its importance here. There is another interesting thing to watch here is this one that this is where a very important microorganism in the soil resides.

So, they are generally, these are, these are the fungi, the fungi can, fungi are, fungi are generally you can see their activity level increased, there activity level increase at lower pH, so about 5 but you know remain, remain does not change much after between say 5 to or from 5 to 10, from 5 to 10 there the fungi do not change much. Secondly, here you can see this bacteria, so this bacteria if you just observe here another important aspect of bacteria is this. So, bacteria, bacteria and bacteria and actinomycetes and actino actinomycetes. So here, so this is where most of, in most cases the soil you know this is where the activity levels so you know this is where this is, this is what is this is nutrient availability for the plant to uptake. We generally call is an uptake, plant uptake. So, this is where, this is where you can see now if you just try to observe this what is

significant in this plot here is that this plot if you just try to observe this, this is the level, this is the area we would generally like to keep the soiling. So, if you are trying to remediate salt this should be an area which is safe for us. So, you know between you can very well see this in, if we are between 6 to 8 pH, if we are between 6 to 8 pH then we can think of, we can consider that you know there this is, this is about the microorganismic activity, microorganismic activity. So, here so as we can see this would be the level, as you can see here this would be, this is the place that we have already been doing this, so here you can see that you know the difficult part you know we would keep the, try to keep the potassium and sulphur at this pH would say mostly about this whereas in this, in the case of manganese if you are just trying to keep this manganese like this, the iron remaining here okay.

So, here as you can see this particularly the, for the fungi and the bacteria's you can see this is the activity level where we would generally try to keep the fungi and bacteria. So, here if you just see this plot now, if we just see this plot now the best region is perhaps the best region is perhaps the 6 and 7, the best region is between 6 and 7. This is where we would try to keep and this is to suggest and this is to suggest, so here at 6 to 7, at 6 to 7 if you are trying to keep the soil, as I keep to soil then we are comfortable, we are comfortable. This also suggests that this also suggests this is clear to you. Yes, so you can see this is where this is the, this is the area where you should try to keep the soil pH to remain the, to encourage, to encourage the microorganismic activity and nutrient availability for the plants.

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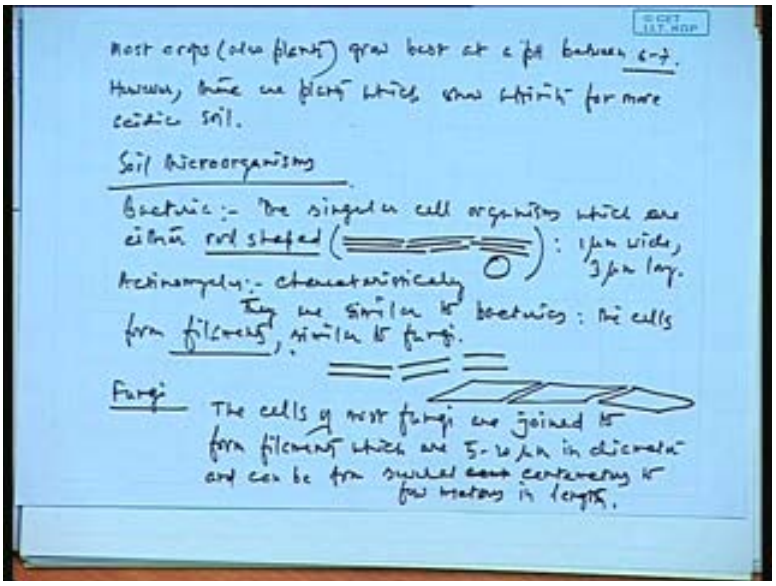

So, generally as I have said that the most crops, most crops, crops also, also plants grow, grow best at, grow best at a pH, at a pH between 6 and 7. There are however there are, there are plants which show affinity, affinity for more acidic soil but then again that is you know that is always possible that is always, that is always the situation that we can think of that is always the situation that we can think of. So, you know however there would be most crops, we just most crops or plants that we would generally try to keep is between 6 to 7 however there are plants which show affinity for more acidic soil okay.

Now having to, having gone from here, having gone from here so you know if you just observe this now there are few things that I would like to say you know there are few things that I would just try to point out here is this soil microorganisms. You just see this soil microorganisms, soil microorganisms, soil microorganisms are as you can see now the soil microorganisms that we have discussed, soil microorganisms, soil microorganisms which are the soil microorganisms say this very elementary description I am not going to in large detail but you know these are important for our case. This is bacteria, bacteria says this singular cell, singular cell organisms which are, which are either, which are either rod shaped, which are either rod shaped. That is you know showing like this, this is how they would stay, this is how this bacteria's look like, they would stay like this you know rod shaped, rod shaped. The width of this rod should be 1 micrometer wide and 3 micrometer long, 3 micrometer long, okay. So, this is you know this is 2 centimeter long, say you know another term I said you know actinomycetes, characteristically they are similar to bacteria's, characteristically, characteristically they are similar to bacteria's.

How they look different, the cells form filaments, so cells form filaments. This one, this are rod shaped, these are filament shaped. So, you know filament shaped is you know instead of having a rod, the rod being you know like this you know this, this is about a rod kind of cylindrical rod structure that you see whereas this one would look like, this one would be this is, this one would be more looking like this but this one also, this one would be but if you just observe them instead of a rod they would look like this, they would be more like filaments, okay. These are the filaments, filaments quite similar to fungi, this quite similar to characteristically they are similar to bacteria's. The cells form filaments which may, which is also a similar filaments similar to, similar to fungi, similar to fungi, fungi.

Fungi are the cells of, the cells of fungi, most fungi are joined to form filaments, form filaments which are, which are 5 to 20 micrometer in diameter and can be and can be from, from several, from several centimeters, centimeters to few meters in length. The cells are, cells of most fungi are joined to form filaments which are 5 to 20 micrometer in diameter and can be, can be from several centimeters to few meters in length. This is fungi, this is fungi you know say the typical fungi you know is all this, there, there are many kind of this mushrooms that we have seen, this mushrooms are essentially fungi.

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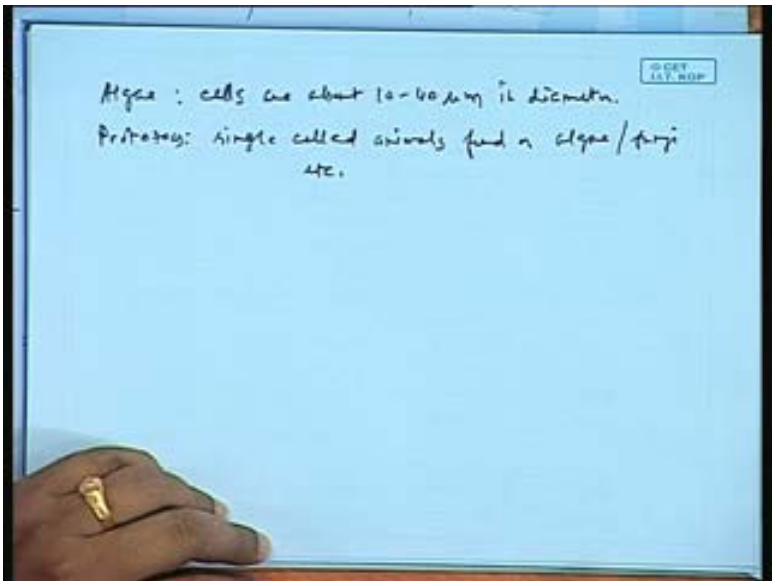

So, apart from that there are few more you know that I will just not, these are called say algae that you know algae this is the cells, cells are about 10 to 40 micrometer in diameter then there are protozoa's, then there are protozoa's single celled animals feed on, feed on, feed on algae, fungi etc, feed on fungi, single celled animals feed on algae, fungi etc. So, why I have mean to mean to say this you know why I have brought this in, why I have brought this in this is critically important because you know one is you know you can understand the food chain now. This is where the food chain starts, so you know if the food chain starts means you know in a whenever in an, in an environmental situation you know situation when the environment is trying to regenerate itself, the first and foremost sign is at that food chain is becoming established. If you have saw, if you have seen you know say the reclaim soil lands, so I just next time you go to any mining field or any other areas where the soil has been reclaimed, the most important part is you know is to observe that when you think that you know the soil is, the soil is inviting some larger animals like you know if you find a snake in the soil or if you find a fox in the, in that area or the you find the foxes are moving around that area, you can be sure of that the soil is regenerating itself. So, that is what is very important, so is for us to understand to establish first for a reclamation or say for an environmental engineers point of view, the first and foremost thing is to observe that the whether the food chain is becoming established or not.

If you observe a certain food chain is becoming, becoming visible, a food chain is becoming visible so smaller animals, smaller microorganisms feeding on the even smaller microorganisms and then going up in the food chain. We can very well say that the soil is coming back to its own potential. So, that is absolutely important in terms of reclamation engineering, in terms of an environmental engineering. The … of environmental engineering remains with this that whenever we are trying to do something, we must try to see that whether the natural system that used to exist or that still exist in some other areas can be replicated or can be brought back to this area again. If we are successful to a certain extent, we can consider that to be you know the job of reclamation engineer or an environmental engineering is successful. So that is the most important part apart from that, apart from that there are some soil you know soil, other soil fauna

that we generally discuss of. Well, I will not going to that the soil fauna, this typical you know the soil fauna let me explain you here, some of this things here.

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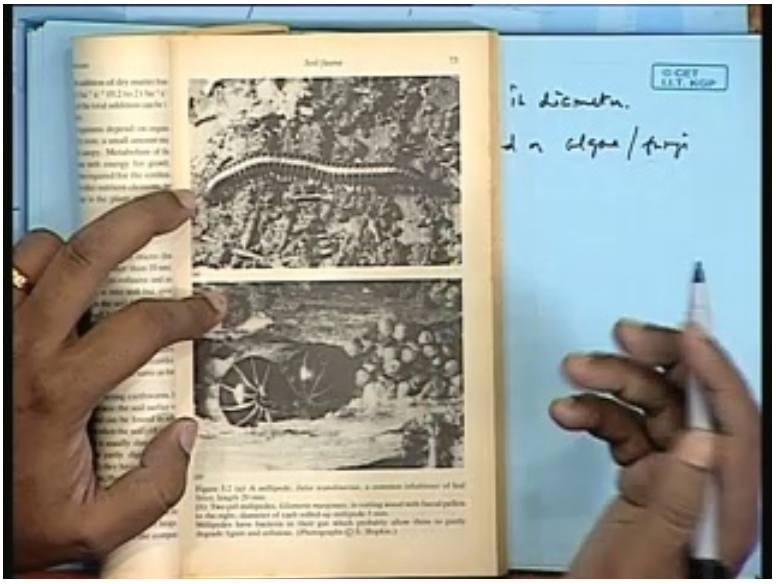

As you can observe here a soil fauna here is this is a millipede that you can observe that you can see in the soil mostly you know very well visible. If you just take of any soil you know you can think of these millipedes. This also is an another example of that the soil is active, the soil is a then the we can say this pill millipedes you know these are small, small millipedes that you can generally observe, you can see this is a common in eminent of leaf litter, length 20 mm, they are generally above 20 mm in length. So, this one is the rolled up millipede, the rolled up millipede is about 5 mm.

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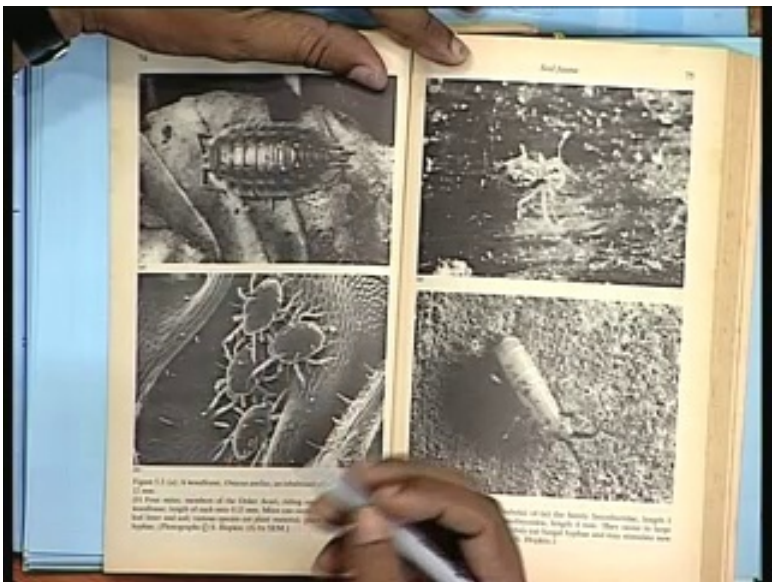

These are the other insects, the insects and this say the typical you know a typical fauna that is generally observe the millipedes and all this you know say this is if we just observe this, this one particularly you can see this is a wood loves that is we generally you know this area of Kharagpur is very famous of wood loves, you know this is the termites, the family of the termites you know wood loves in the family of the termites. Then this is as you can see this you know they are, they are generally you know, you know scanning electron microscope, under scanning electron microscope you can see this the fomites member of, this one is length of about 0.15 mm, 0.15 mm diameter, these are moving around. So, this can be under you know standard this scanning electron microscope this is how it looks like. So, these are, there are this spring tales the other kind of soil microorganisms this this is, this one is another the very typical soil, the very typical one, the very typical one that you can see here also is the something like the earthworm, the typical earthworm that we generally observe.

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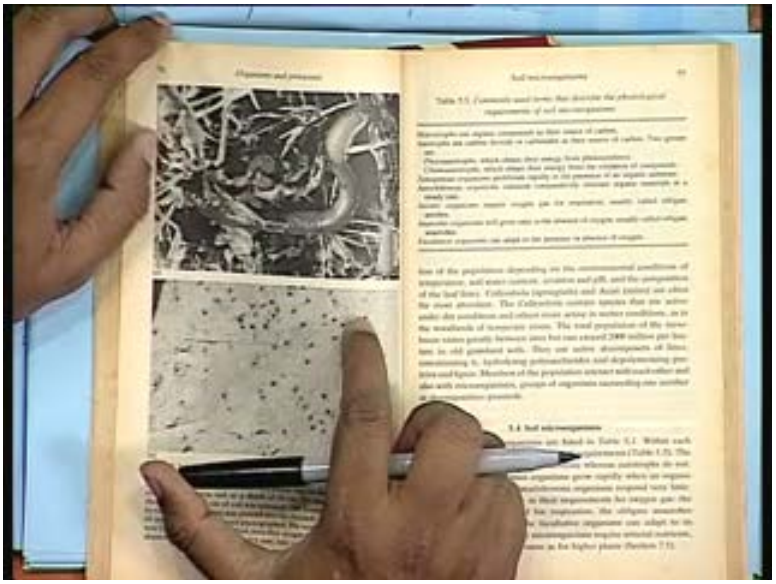

It is another interesting thing I mean you know if you can think of you know in our childhood, we use to see lot of earthworms in the soil okay you see you could very well see earthworms you know in the soil particularly during rainy season. You would see that the earthworms coming out but when we are we are started to use pesticides and whenever this kind of cultivation has coming wherever there we have used a number of fertilizers and different kinds of pesticides, their numbers have gone down. So, here again you know this is, these are the indicators in the soil. If the soil is good you will find these earthworms are coming back, you will find that the earthworms are more existence there. Unusually you know many people take a different view nowadays, you know they generally think these are nuisance but these are the important part of soil, these you know even without being an engineer if you just try to can appreciate that the soil should have all this thing and our effort should be, should be to see that you know as reclamation engineer or an environmental engineer to bring back a condition where this kind of insects, this kind of microorganisms can live in the soil then our job is done then you're successful by all measures.

So, here it says the other things would follow, you will find plants growing, you will find grasses there, you will find you know larger insects, you will find snakes there, foxes there, you know the all kind of things would begin to move on but unless you see them, you are never sure whether you have been actually successful or not okay. So, here is says this is what you know I will not go into the discussion of this, I will not go into the discussion of this, we can see most of them in rainy season. Yeah, then is that mean the soil regenerates more in rainy season. Well, one thing is this most of this I mean this say earthworm and things like that they generally remain at a say between say about up to 50 centimeter or 100 centimeter in the soil depth. Generally, remain you know they come out in the rainy season just because of their, their holes become filled up with water, also there may be some reproductive behaviour also can bring them out, there is some kind of reproductive behaviour.

Well, I mean one thing can be said, say about rainy season. Yes, you are to a certain extent right because you know in most cases you will find that the rainy season is when the food is maximum available in the soil. If it is the food is maximum available about that time is the period when the reproductive cycle begins, the reproduction essentially begins at that time. So, all kind of animals insects smaller microorganisms they become more active during that time because you know that is the season where they reproduce, mostly they reproduce many of them reproduce. So, you know that is what one thing you will find that their activities grow and particularly in various other things like, so when the food is available reproduction basically deals with that. See, you know in our, you know even in human culture also they say the softer this paddy, the growth of paddy and all this why the festivity is basically it directly and indirectly points towards the good season for reproduction. That is how it has come into the human culture also. So, this is what you know this is why, this is why you know this you can see this that these are mostly this organisms the fauna that is available in the soil. So, as a reclamation engineer our objective is to, our objective is to see that these are the things, this things are, this things are protected, this things are protected.

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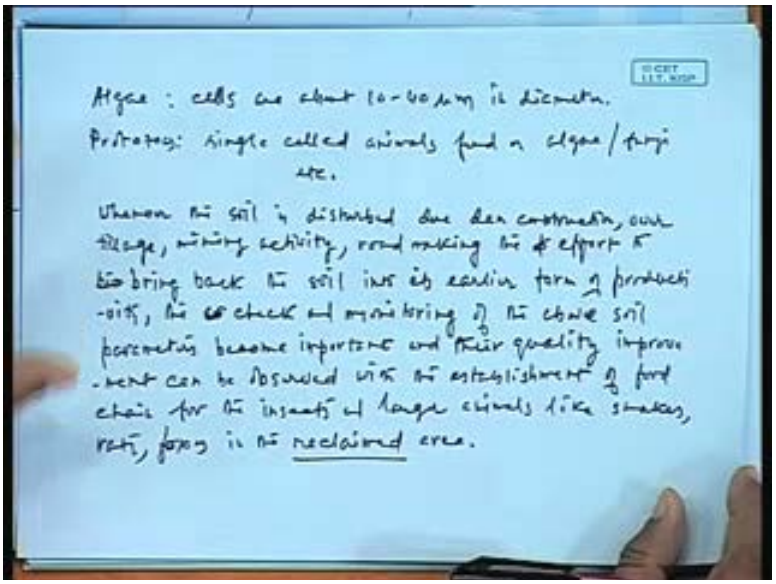

So, here again you know let me tell you one another important thing here that is to say you know whenever the soil is disturbed due to, due to say, due to dam construction, the dam construction over tillage, over tillage, mining activity, mining activity, road making, the effort to bring back the soil, effort to bring back the soil into its earlier form of productivity, the check and monitoring, check and monitoring of the above soil parameters, the check and monitoring of the above soil parameters become important, become important and their quality improvement and their quality improvement, the check and monitoring of the soil parameters become important. Their quality improvement, quality improvement can be observed with the establishment of food chain for the insects and larger animals like snakes, rats, foxes in the reclaimed area. That is reclaimed area is the area where you are working, where the soil has been disturbed due to some activity mining, road construction, over tillage or say you know dam construction or anything like that the soil is damaged.

The early sign that the soil when you are working on the soil, where you are working on the soil to improve the quality of the soil, the early check that you can see is that whenever you are seeing that the establishment of food chain has started or it is maturing up, you observe that the establishment of food chain has been taking place in the reclaimed area, you can see that to be a sign of soil improvement, that to be a sign of soil improvement. So, here again you know we would know next go on you know we will further carry on this thing through, this is the soil vegetative parameters in the parameters for soil growth are complete. So, we have already discussed almost all parameters that are necessary for soil growth, you know if you have this much idea about soil for establishment of the plant, seed germination of seeds and establishment of plants you are surely good enough in a dealing with most of the soil problems. Again on this you know there is another important area you know that should, we should discuss is the soil erosion.

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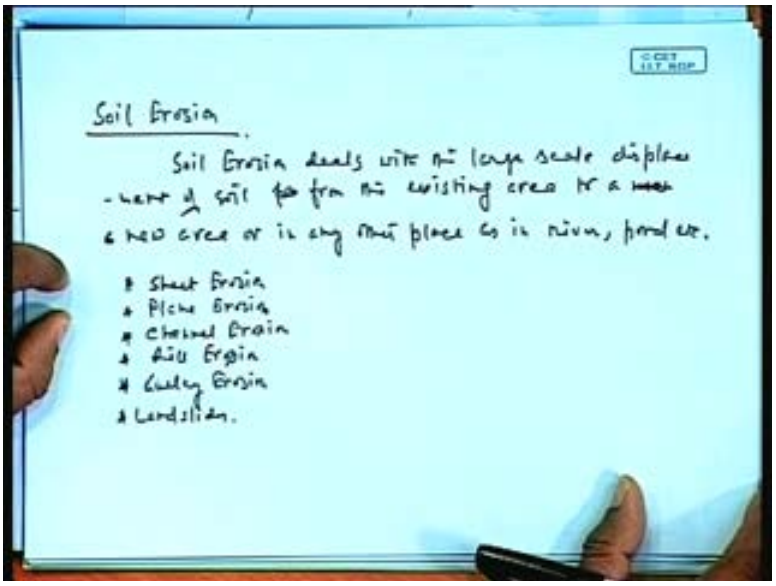

Soil erosion, soil erosion deals with, soil erosion deals with, soil erosion deals with the large scale displacement of soil from the existing to a new area, etc. The soil erosion deals with the

large scale displacement of soil from the existing area to a new area or any other place as in river, pond etc, okay. So, as in so you know is if it is moving from one place to another, from one land surface to another land surface that is also an erosion. If it is moving from one land surface to another, another medium like you know in the water, in a pond, in rivers also that is also soil erosion. We will deal with this after 5 minutes break right, okay.

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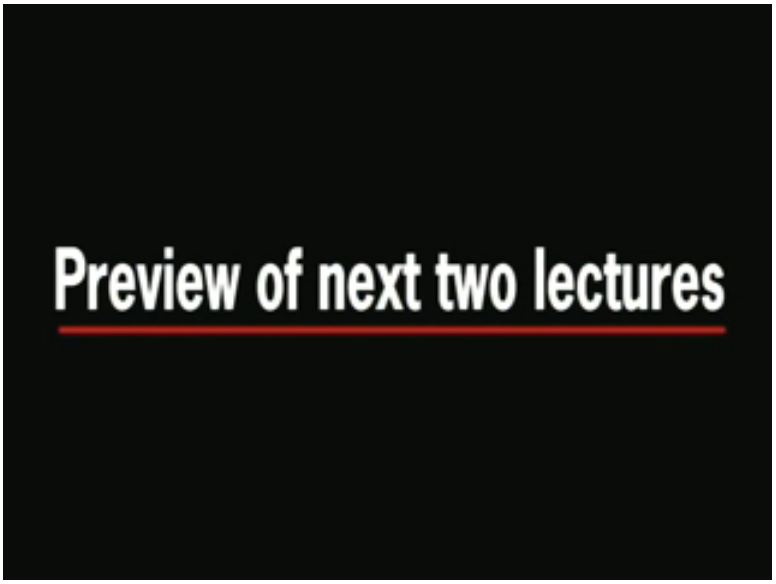

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So, we were dealing with this soil erosion and you know and is just a, just now that we have introduced soil erosion due to the large scale displacement of soil from existing area to a new area or in any other place as in river, ponds, etc okay.

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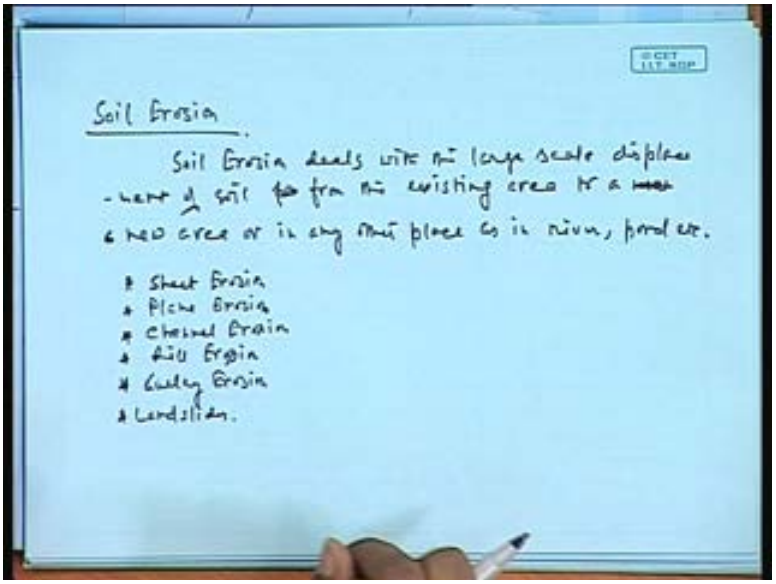

Now, having to say that there are few important things that you know the different kinds of soil erosion that we discuss today is that you know one is called sheet, sheet erosion, sheet erosion also called you know is also known as it's okay there is another called plane erosion, plane erosion. The third one is you know you is now then we can say this channel erosion, channel erosion then rill erosion and finally would also take a little bit on this is also a part of erosion only this is landslides, landslides, okay. So, having to say this, this is the channel erosion, plane erosion, the sheet erosion, plane erosion, channel erosion, rill erosion, galley and landslides, let me further explain on this.

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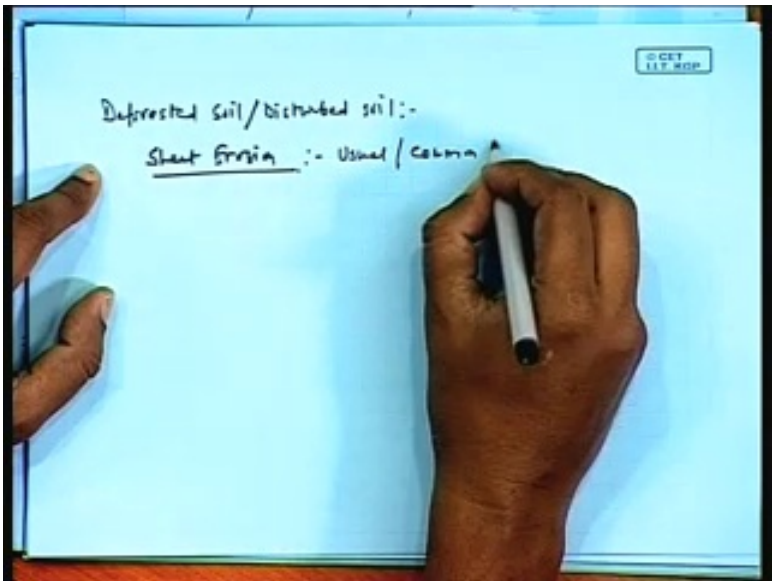

What happens here is if you just observe this things you know in a somewhat more detail in any kind of soil, in any kind of soil it is particularly in a say deforested soil or say mostly say deforested soil or disturbed soil, disturbed soil. The erosion that is quite common is sheet erosion. Also the sheet erosion is an usual form of erosion is a very typical, very common type of erosion that is usual and common, begin to increase and can reach about and can reach about and can reach about 30 to 40 centimeters, can reach about 30 to 40 centimeters, 30 to 40 centimeters.

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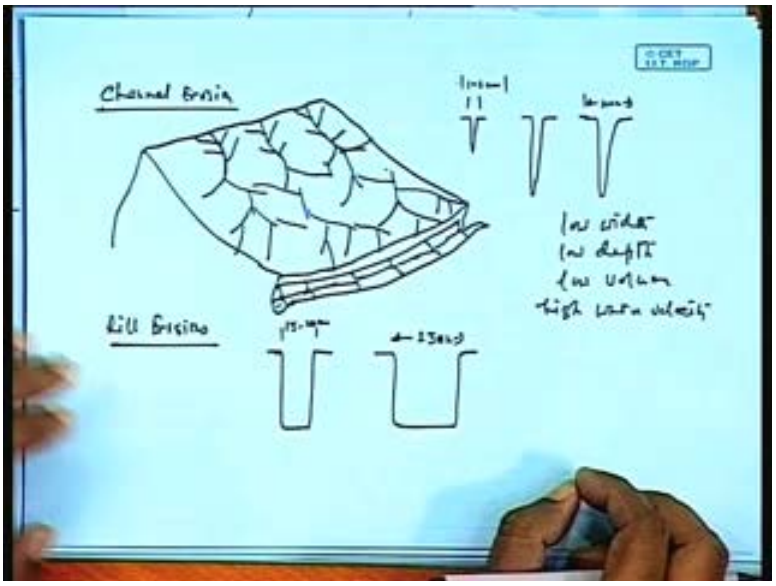

Since, they are of low volume, they are of low volume, they allow water to flow, they allow water to flow in high velocity, they allow water to flow, the rain water to flow in high velocity,

they allow the rain water to flow in high velocity thereby increasing erosion, thereby increasing erosion, thereby increasing erosion, thereby increasing erosion at the bottom, there by increasing erosion at the bottom as well as in the top, as well as in the top. When only, when only the rills begin to form, when only the rills begin to form, begins to form, begins to form, begins to form, rill erosions begin to form. All this, all the above erosion, all the above erosion decreases the amount of soil particles and the amount of soil particles those what they do is generally cut them into pieces and spread over the soil.

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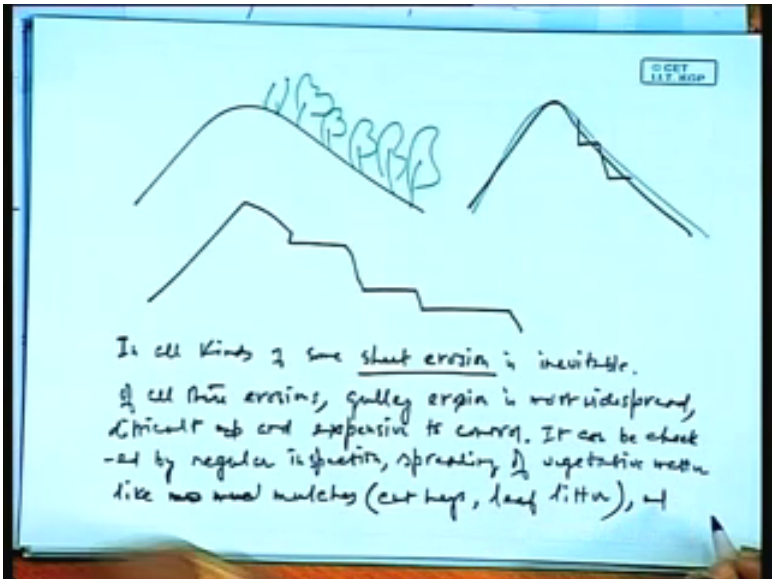

So, this is one way of spreading, reducing say spreading, cut heys, leaf litter and by which inspection and other mechanical means and other and other mechanical means, other mechanical means, other mechanical means.

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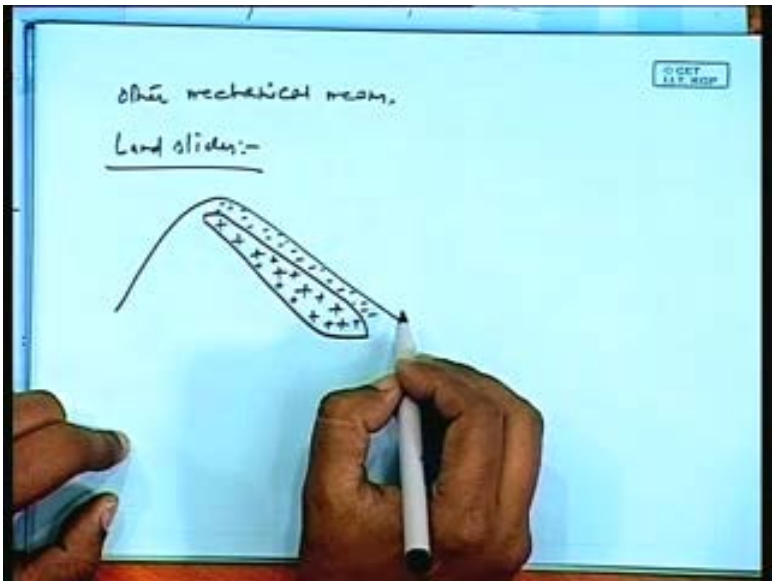

So, this is, this is can be only be restricted like this. Having to say also you know is mostly another important aspect is the landslides. The landslides you know somewhat different you know in the sense that mostly, mostly the landslides usually is also related to denudation of forest, denudation of cutting of trees essentially is also related to the cutting of trees but there is some characteristic difference here. We just say you know suppose there is a, there is a, there is a, there is a say a particular rocky surface here you have soil, you have soil, here you have soil. If you make a section, if you make a section across say you know across any slope because section across any slope and this is what is the rock surface say you know any granite or sandstone, the typical types of basalt or any kind of rock surfaces that we generally observe here. What happens is, what happens is this essentially does not form in the form of a sheet erosion or a plane erosion.