Soil Science and Technology
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Lecture – 45
Organic Pollutants in Soil

Welcome friends to this 5th lecture of week 9 of Soil Science and Technology. And in this lecture, we will be finishing this wind erosion and we will be talking about different control measures of wind erosion and then, we will be talking about different organic pollutants which are present in the soil.

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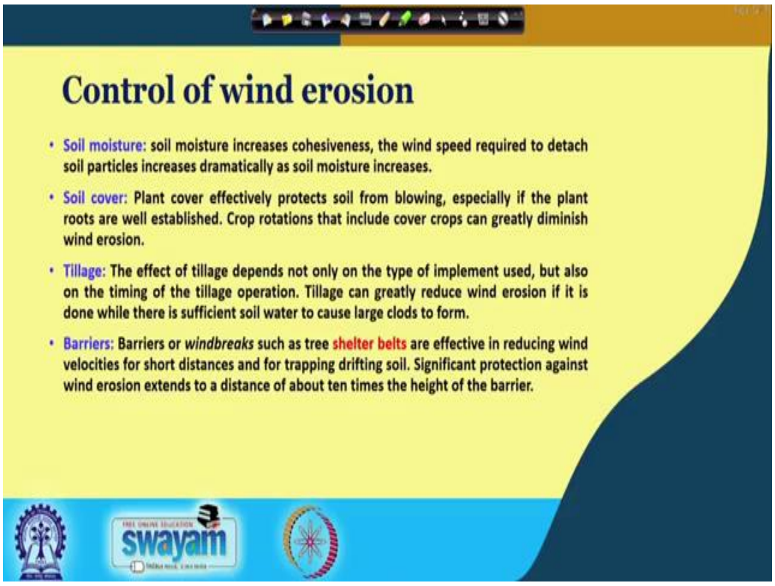

And so, in the last lecture, we talked about different what is wind erosion, and how we can calculate the wind erosion, what are the different factors of wind erosion. Now, we will discuss about different control measures of wind erosion. So, there are you know several aspects we need to take care of while measuring the wind erosion while controlling the wind erosion.

So, soil moisture obviously, the soil moisture increases the cohesiveness and the wind speed requires to detach the soil particles, you know increases dramatically as soil moisture increases; obviously, when there is a soil moisture, it increases the cohesiveness between the particles. So, we required much more higher you know wind speed, so the you know to detach the soil particles.

Soil cover you know plant cover effectively protects the soil from blowing, especially if the plant roots are well established. So, crop rotation that includes crop cover can be greatly diminish the wind erosion. Plant roots are you know are having much important effect for controlling the wind erosion because they can attach the soil particles, they can anchor the soil particles more strongly.

And tillage is the effect of the tillage depends not only on the type of the implement used, but also on the timing of the tillage operation. For example, tillage can greatly reduce the wind erosion if it is done while there is a sufficient soil water to cause the large you know to cause of the large clods to form.

So, when there is a large clod obviously, there is less chance of wind erosion because there will be requiring high amount of, high wind speed to detach the soil particles or to move the soil particles when they are forming the clods. And finally, Barriers, Barriers of windbreaks such as the shelter belts will be talking about the shelter belts are effective in reducing wind velocities for short distances and for trapping the trapping drifting soil. So, significant protection against the wind erosion and extends to a distance of about ten times the height of the barriers. So, we will be seeing that.

So, all these five, you know four aspects need to be considered while we are thinking about any designing any method designing any as you know any management strategy for controlling the wind erosion.

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So, you can see this an example of wind erosion control in a China. So, ecological engineers, they can use the checker boards straw checker boards. So, this a new technology where they are using the straw in the form of checker boards and most of the you know some portion of this checker boards are buried into the soil and some portion are exposed over the soil surface.

And as a result of this checker boards, these helps in actually these checker boards are used for erosion control and stabilizing the sand dunes and all these and if. So, also reforestation and you know and for growing the crops. So, these are some of the ways they have used for controlling the wind erosion in this you know Arid Ningxia province in China. So, it is a fairly new technology that they are using.

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So, also there is a the most important you know way of you know controlling the wind erosion is the called the Shelterbelts is basically rows the fast growing trees around crop plants that can provide wind breaks reducing erosion by the by winds. So, generally, we plant the rows of fast growing trees along around the crops. So, you can see these are the fast growing trees around the crops, so that wind is getting obstacle you know wind is facing obstacle while going while flowing through these crop field and thereby reducing the wind erosion.

So, this shelterbelts is you know is the most effective way for controlling the wind erosion from crop field and tillage erosion.

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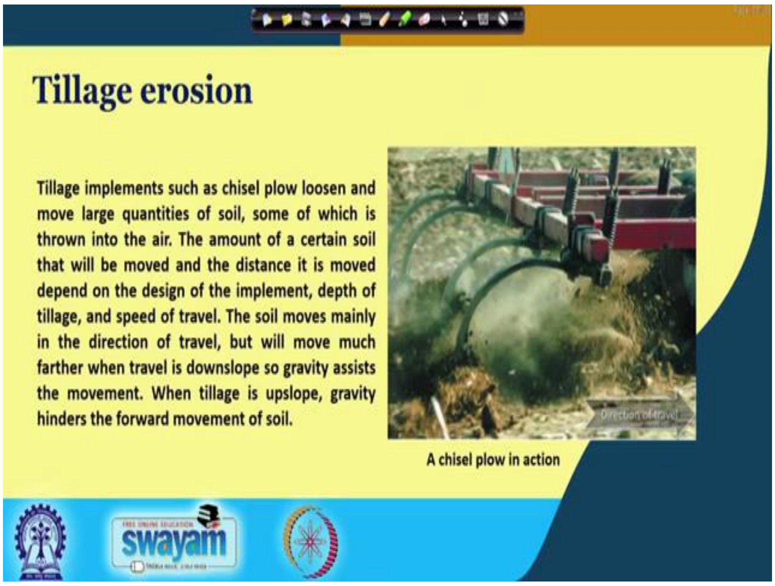

So, tillage erosion because you know there are several tillage implements such as Chisel plow loosen and move large quantity of soil some of which is thrown into the air. I talked about these during our discussion of vertical or turbo tilling practice in conserve in conservation agriculture. And the amount, and as a result of this you know the soil large quantities of soil, which has been thrown away by this tillage implements and the amount of this certain soil particles will be moved and distance and you know and the distance it is move will depends on the design of the implement, depth of the tillage and speed of the travel.

The soil moves mainly in the direction of the travel but will move much farther when the travel is down slope to. So, gravity assist the movement when tillage and then just opposite condition when the tillage is up slope, gravity hinders the forward movement of the soil.

So, you can see here Chisel plow in action and this the direction of travel obviously, as a result of that, these huge amount of you know soil particles which are getting detach and you know thrown away. There we will move along with the wind and they will deposit to other places; obviously, this movement will be much further when the travel is down slope. So, gravity also helps in the movement.

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So, you can see here, these are pre tillage landscape you know this pre tillage landscape, this is a post tillage landscape. Obviously, you know this is the whitish calcareous subsoil material from the Mollisol is mixed into the plow layer of a conventionally tilled filled in a sub humid region. So, these diagram basically illustrates how tillage scalps the hilltops by throwing the soil further down the down, down slope then upslope.

So, you can see here, this is the wind erosion. So, soil basically from this portion thrown by this wind and tillage go further down the slope then upslope and gravity further helps in the movement of this soil particles down the slope here and ultimately this particles will be deposited down the slope resulting in the net movement of soil down slope and gradual levelling of the landscape.

So, we can see ultimately, gradually it is being levelled and ultimately, exposing the whitish calcareous subsoil material from the mollisol. So, you can see this pictures also. So, ultimately as a result of wind movement, the topsoil is getting moved downwards and helping and which is further assisted by the gravitational movement and ultimately exposing the subsoil and ultimately levelling the ground.

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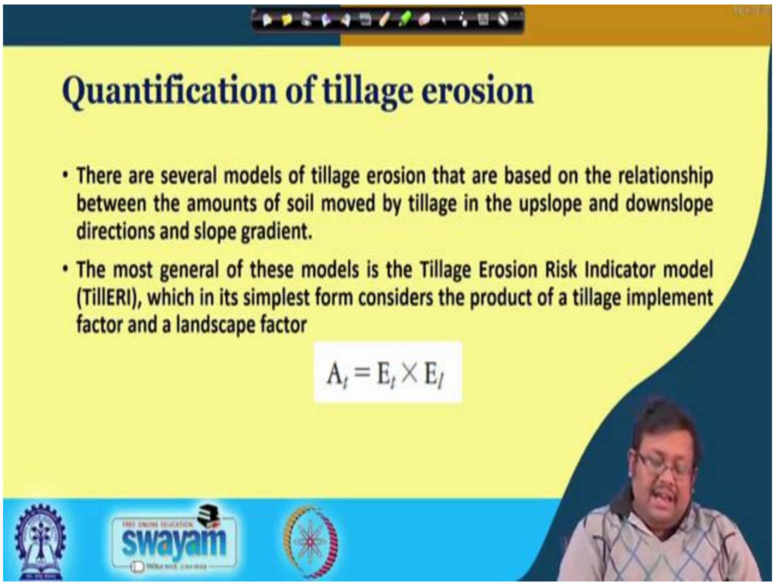

So, quantification of the tillage, tillage based erosion, there are several models of tillage erosion that are based on the relationship between the amount of soil moved by tillage in the upslope and down slope direction of slope gradient. The most general of these models is tillage erosion risk indicator model, we you know when the short form is till ERI and which is the simplest form considers the product of a tillage implement factor and a landscape factor.

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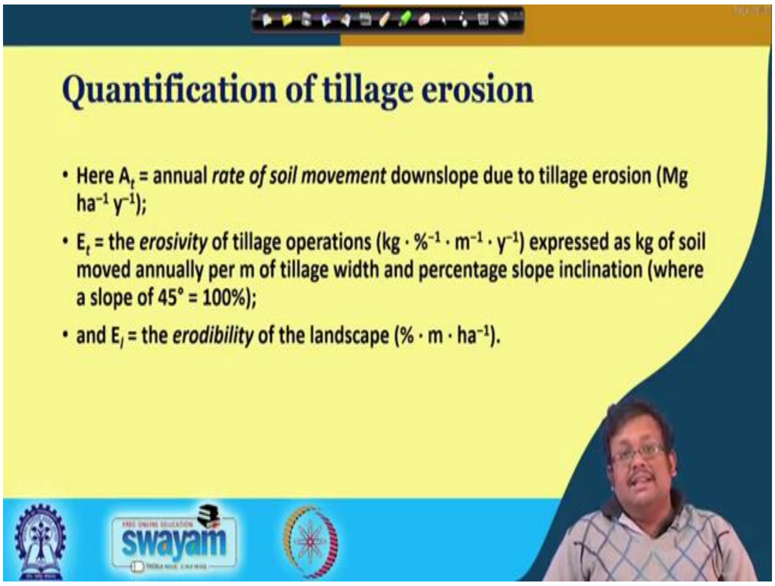

So, this equation is basically, At equal to Et multiplied by El where A t is the annual rate of soil movement down slope due to tillage operation. It is mega gram per hector per year. And Et is basically the erosivity of tillage operations which is expressed as kg of soil move annually per meter of tillage width and percentage slope inclination where you know a slope of 45 degrees considered as 100 percent and El is basically the erodibility of the land slate of the landscape.

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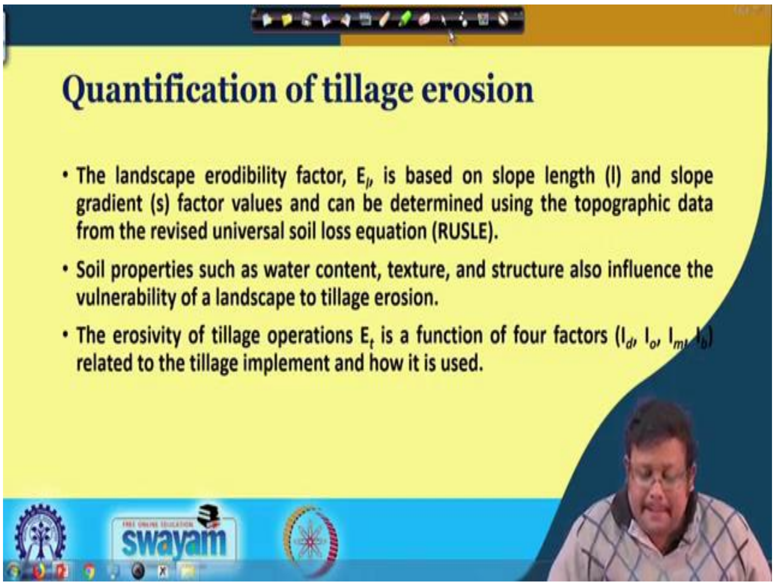

So, how quantification of the tillage erosion, so the land landscape erodibility factor or this El is based on slope length or small l and the slope gradient that is s factor values and can be determined using the topographic data from the revised universal soil loss equation, R U S L E we have already discussed about this revised universal soil loss equation.

At the soil properties such as water content texture and structure also influences the vulnerability of the landscape to tillage erosion, we have covered all these things in our previous lecture. So, I am not going to discuss this in further details. And remember that, the erosivity of the tillage operation Et is a function of four factors. These four factors are basically Id, Io, Im and Ib. And all these four factors are related to tillage implement and how it is used. So, let us see what are these factors?

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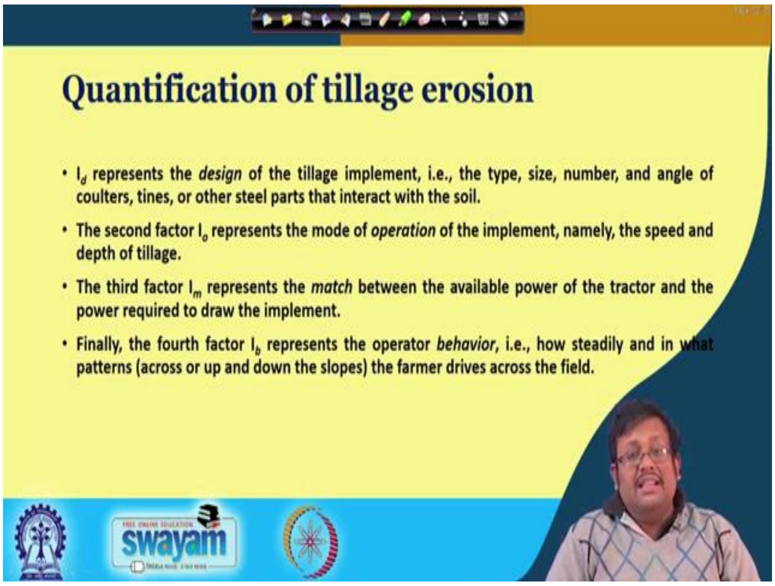

So, these factors this Id represents the design of the tillage implement that is the type, size, number and angle of the coulters tines and other steel parts that interact with the soil. The second factor Io represents the mode of operation of the implement namely the speed and depth of tillage. And the third factor Im represents the match between the available power of the tractor and the power required to draw the implement.

And finally, the fourth factor Ib represents the operator behaviour that is how steadily and how and in what patterns across or up or down the slope the farmer drives across the field. So, these tillage erosion is also an inter play between these individual factors and all these factors are taken into account while we are collecting the tillage based erosion.

So, guys please you know, I am just giving an overview of these erosion practices erosion you know cultivation. There are several models available in the internet and you can make a Google search to learn in details about this models. And I hope that you have learned several things in this lecture or in this topic and let us wrap up this let us wrap up this wind erosion and tillage erosion and move to our final topic of this week that is toxic organic chemicals in soil.

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And so, talking about the toxic organic chemicals in the soil, there are several ways through which this toxic organic chemicals can be present into the soil. Obviously, these you know several ways like accidental leakage, then spills, then through planned burial and spraying and other treatments.

Now, you can see here there is an accidental spill of crude oil or petroleum in an area in Israel. So, that is the way through which this organic chemicals press you know organic chemicals you know are spilled or you know present in the soil environment.

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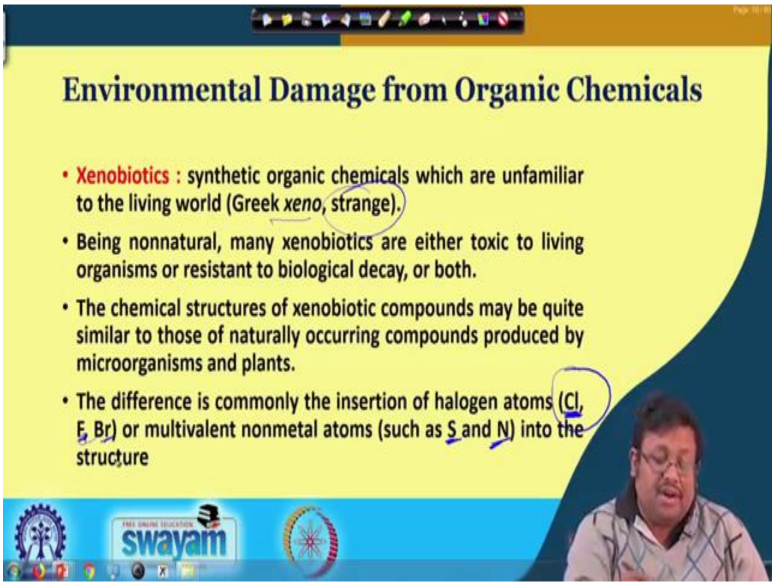

So, let us also discuss about the environmental damage from different organic chemicals. For discussing the environmental damage from organic chemicals, we first have to you know discuss about the Xenobiotics. Remember this an very very important term. And xenobiotics are basically synthetic organic chemicals which are unfamiliar to the living world and it basically comes from the Greek word Xeno; that means, strange.

So, being non-natural, many xenobiotics are either toxic to living organisms or resistant to biological decay or both. So, this xenobiotics, I mean all this organic chemicals which are present into the soil organic pollutants are which are present into the soil, they can they can pose a serious threats not only to the existing you know the soil microorganisms or macro organism, but also it poses serious threats to the ecosystem to the crops as well as to the plant to the human health.

So, this xenobiotics again these are synthetic organic chemicals which are unfamiliar to the living world and they are coming from this Greek work Xeno; that means, strange. So, being non-natural many xenobiotics are either toxic or to living organisms or resistant to biological decay or both. And the chemical structure of the xenobiotic compounds may be quite similar to those of naturally occurring products by microorganisms and plant.

And the difference, there is a obviously, a difference. The difference is commonly the insertion of halogen atom. So, in the xenobiotics we will see there is an insertion of this halogen atoms like chlorine, fluorine, bromine or multivalent non-metal atoms such as sulphur and nitrogen into the structure.

So, again this xenobiotic structure may be quite similar to those naturally occurring compounds; however, you will see the predominant of chlorine, fluorine and bromine as well as multivalent non-metal atoms sulphur and nitrogen in the structure of the xenobiotics.

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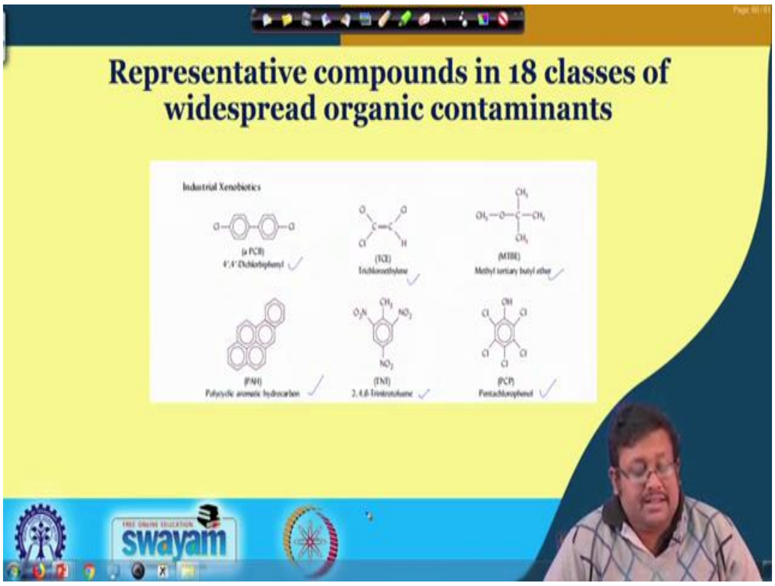

So, let us see the representative compounds in 18 classes of widespread organic contaminants which are present into the soil. Let us start with the xenobiotics. Obviously, the industrial xenobiotics, you can see we can see a PCB or polychlorinated biphenyls. This is you know dichlorobiphenyl and obviously, this is a trichloro ethylene.

And this is MTB; that means, methyl tertiary butyl ether and this PAH that is polycyclic aromatic hydrocarbon which is with these polycyclic aromatic hydrocarbon is present when there is a petroleum spill. And TNT or 2 4 6 trinitrotoluene it is an explosive and also a PCB that is pentachloro phenol.

So, all these are industrial xenobiotics and this industrial xenobiotics creates a huge amount of you know in a you know environmental effects. Specially, this PAH they are you know they are the cause of different types of carcinogenic effects and we must be very very careful when there is a you know when there is an oil spill and also this other industrial xenobiotics are also very very environmentally harmful.

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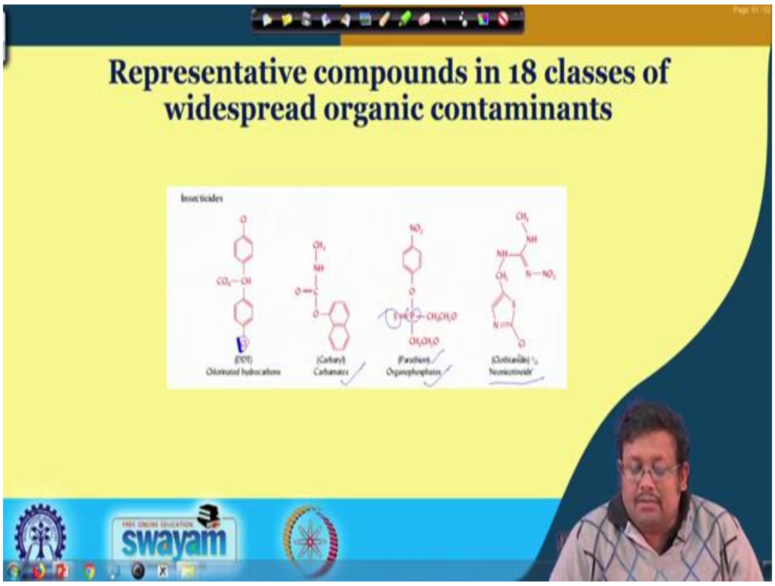

So, let us see the insecticides you know insecticides are the major organic pollutants which are present into the soil. And let us start with the DDT which is chlorinated hydrocarbons. You can see in the structure as I told you the chlorines are present and you know the chlorines are present. So, it is a chlorinated hydrocarbons, then carbaryls carbaryls are you know carbamates and you know parathion which are basically organophosphate group of insecticide.

So, you can see here sulphur is present as I have told you. And so, this is very very important. So, sulphur is present in the parathion or in the organophosphate and also phosphorous is present here. And clothianidin which basically represent this neonicotinoids which is also an important pesticide you can see this chlorine is present, sulphur is present, nitrogen is present. So, multivariate or non-metal cations are non-metal ions are present and also the you know this chlorine is present in the neonicotinoids. So, creating you know environmental hazards. So, these are all insecticides.

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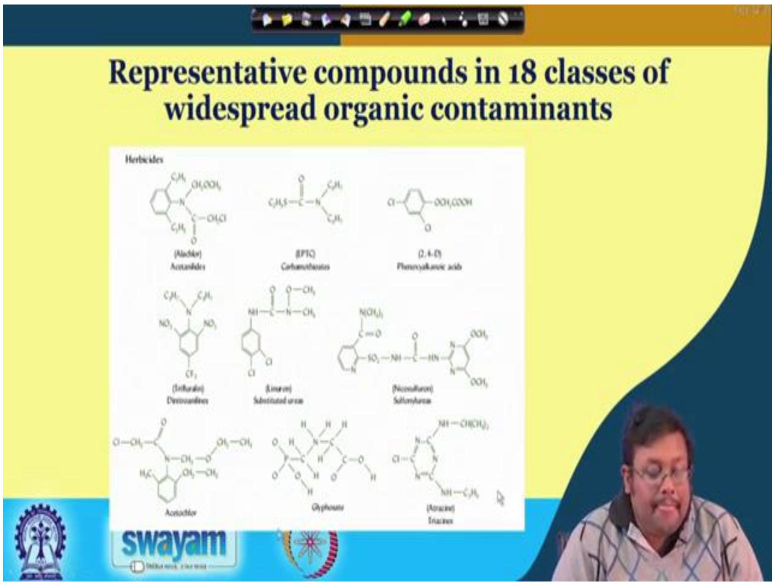

Let us talk about the herbicides which are gaining very very importance nowadays because the consumption of herbicides is increasing day by day. Important herbicides you can see here Alachlor which are coming from the acetanilide groups. And then, EPTC which are representing the carbamothioets and then, 2,4 D or which is basically phenoxyalkanoic acids and then, trifluralin which is dinitroaniline and then, lineurons which is basically substituted urease and you can see nicosulfurons which are basically sulfonylureas and this is acetochlor and then glyphosate and atrazine which are representing triazines.

So, you can say all these are herbicides and you can see all these which I have discussed starting from xenobiotics and then insecticides and these herbicides. This represent 18 classes of widespread organic contaminants which are present in the soil environment and thereby you know thereby creating different health related hazard as well as environmental hazards in the in the soil ecosystem.

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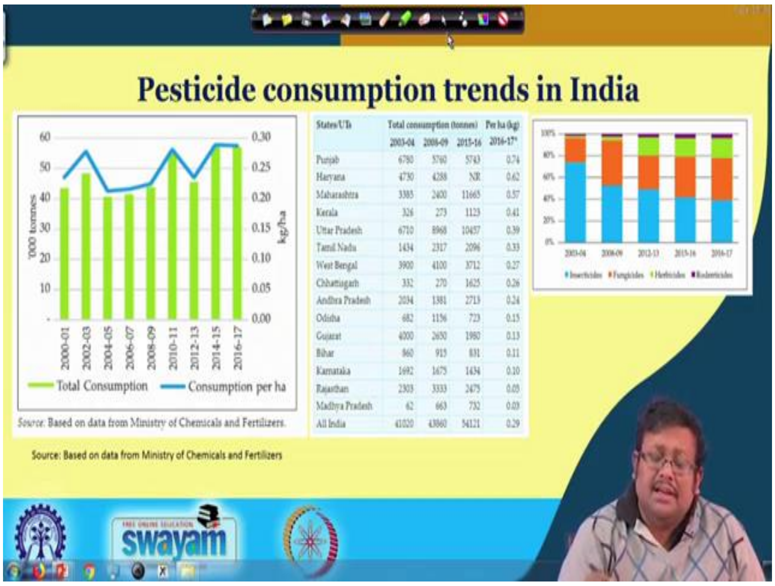

So, if you see the pesticide consumption trend in India, this pesticide consumption trend in India, you can see here in 1000 tons there is a continuous increase in pesticide consumption up to 2016 and 17 and you know you know 14, 15 and 16 and 17 and obviously, the, so this green bar basically shows the total consumption and consumption per hector also increases.

So, there is a continuous increase in consumption per hector. Obviously, for last two year, there is almost virtually stagnation; however, you can see in the you know ultimately they have increased from the starting that is at the you know in 2000, and 2001; obviously, the consumption was fairly less.

And if you see the state wide consumption of you know pesticide, if you see the total consumption is higher in certain states like you know in Punjab it is very very high, in Maharashtra it is also high you know and in Uttar Pradesh it is also high. So, all this states like Punjab, Maharashtra, Uttar Pradesh.

All these are showing high pesticide consumption as compared to you know and per kg per hector utilization of per hector consumption of pesticide is also increase in we high in case of you know Punjab and Haryana and as well as you know other states like Maharashtra and you know and so on, so forth like Kerala and Uttar Pradesh.

And if you see the composite, I mean the you know thus you know the use of different types of pesticides; obviously, the pesticides are insecticides can be differentiated into insecticide fungicide, herbicide and rodenticide. And if you change the change in, use of different types of pesticides along over the time, you can see the while the use of insecticides is getting reduced, the use of fungicide and also the use of herbicides and also the use of rodenticide are getting continuously increase along the time.

So, you can see that the pesticide consumption trends are India showing the increasing pattern; some states are showing high consumption of the pesticides and that is why you know it is very very detrimental for those ecosystem. Specially, I would I will talk about the Punjab where the per hector consumption of the pesticide in 2016, 17 you can see this highest and as a result of that, there is always more incidents of human health hazards like cancers and other effects. So, this shows the effect of persist you know of this pesticides in Indian condition.

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And so, what are the problems coming from the pesticides; obviously, there are several aspects, several problems first of all public health impacts, we will discuss that and then domestic animals death and contaminations is another effect. The loss of natural enemies when we are continuously increasing the pesticide or insecticide, there is a you know there is a inherent you know somewhat resistance is being grown within the pest and also some loss of natural enemies pesticide resistance I have tall talked about it.

Honeybee and pollination losses, we are seeing because of these, pesticide based poisoning crop losses increase of a increase of a serious consumption sometimes damage the crops, fishery losses because these pesticide will ultimately move away through the runoff and ultimately deposit into the different water bodies creating you know toxic condition bird losses and also groundwater contamination.

So, these are the different problems which are arising from pesticide contamination in soil.

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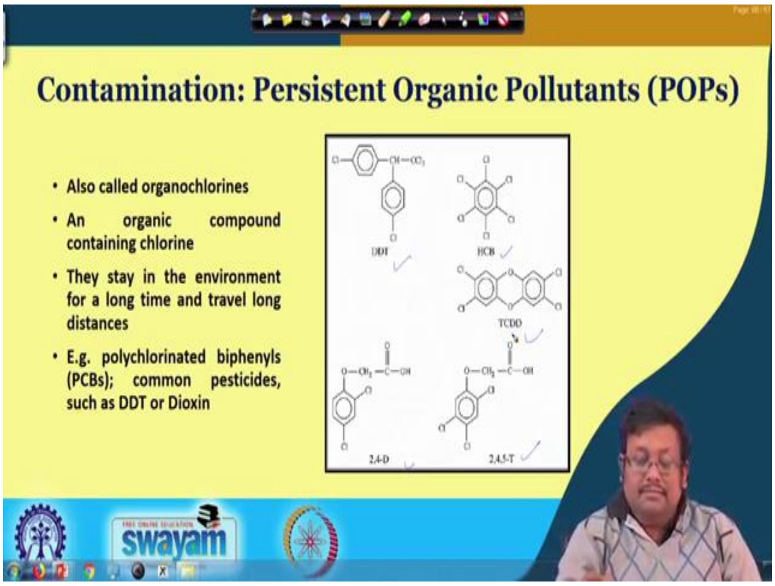

Then, another important term is POP or persistent organic pollutants we also you know these are also coming from the organochlorines as you can see DDT hexachlorobenzenes and TCD and then 2 4 D, 2 4 5 T; are basically the herbicides whereas, DDT, CVR insecticides. So, these are basically you can see these are organochlorines because most all of them are having chlorine in their structure. And you know why they are called persistent organic pollutants because they stay in the environment for a long period of time and travel long distance. So, polychlorinated biphenyls or PCBs are common pesticides such as DDTs or dioxins are these organic or persistent organic pollutants.

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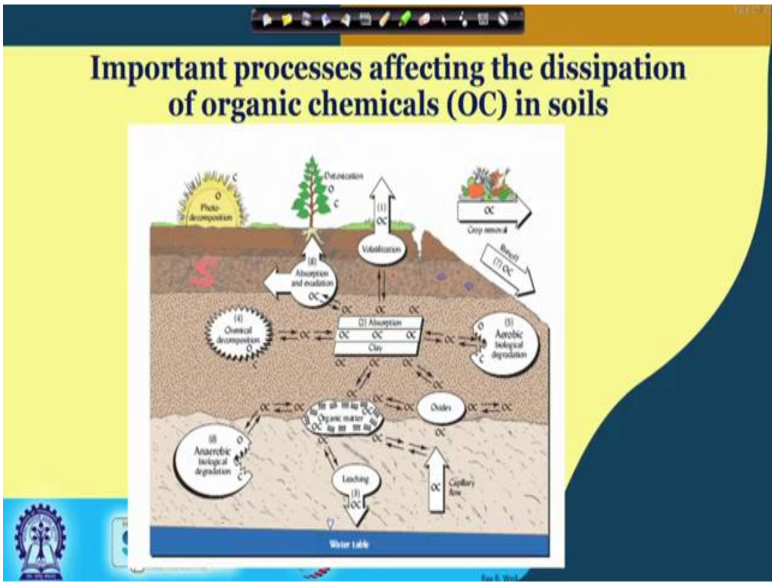

So, if you see the important process which are affecting the dissipation of organic chemicals or you know xenobiotics and this pesticides in the soils, you can see there are several processes. So, it can either goes to the atmosphere due to the volatilization process or it can be adsorbed, this organic chemicals can be adsorbed in the organic matter or clay in the soil or it can leach down to in the water table due to you know in the soluble in the solution form or you know it can chemically decompose by several microorganisms which are present in the soil or you know it can you know different types of into different types of reaction chemical decomposition.

Some biological aerobic degradation occurs due to the microorganism affect at the surface soil layers where there is an where there is a relatively high aeration as compared to sub soil layers and then anaerobic biological degradation occurs in anoxic condition or sub soil layers and then you can see here there is some runoff based losses of this organic chemicals and deposition to other places and finally, absorption exudation by different you know by crops and ultimately, by you know different human you know human body.

So, these are several ways through which this organic chemicals dissipate into the environment and you know they are a different fates of this organic chemicals.

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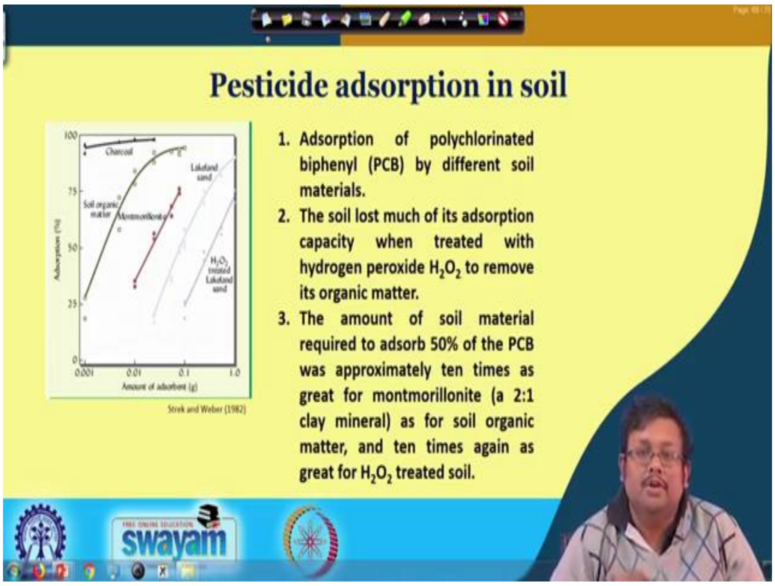

And let us see you know why different pesticide adsorption pattern in the soil? Obviously, this showing the adsorption relation between amount of adsorb adsorbent and adsorption percentage for a particular type of soil. So, you can see adsorption of polychlorinated biphenyl by different soil materials here. So, it basically shows the trend of adsorption of polychlorinated biphenyl which is an important POP by different soil materials.

So, you can see the soil loss much of it is adsorption capacity when treated with hydrogen peroxide because they are basically removing all the organic carbon which is present in to the soil by oxidation. The amount of soil material which is required to absorb 50 percent of the PCB was approximately ten times as great for montmorillonite. Obviously, you can see these are montmorillonite as for soil organic matter.

So, we can soil or this is a soil organic matter curve and this is a montmorillonite based curve. So, you can see, the amount of soil material required to absorb the 50 percent of the PCBs or approximately ten times higher. So, this an amount of absorbent or soil materials and when we are using the H_2O_2 treated soil. Obviously, the amount of soil material need it to absorb these 50 percent of the PCB is also increasing 10 times or more ok.

So, you can see here as the basically these trend shows that as there is a continuous decrease of organic matter; obviously, there will be less amount of adsorption of this pesticide in the soil. So, that is why there is always need for maintaining a good amount of organic matter into the soil to retain more pesticide into the soil and restrict their movement to other places.

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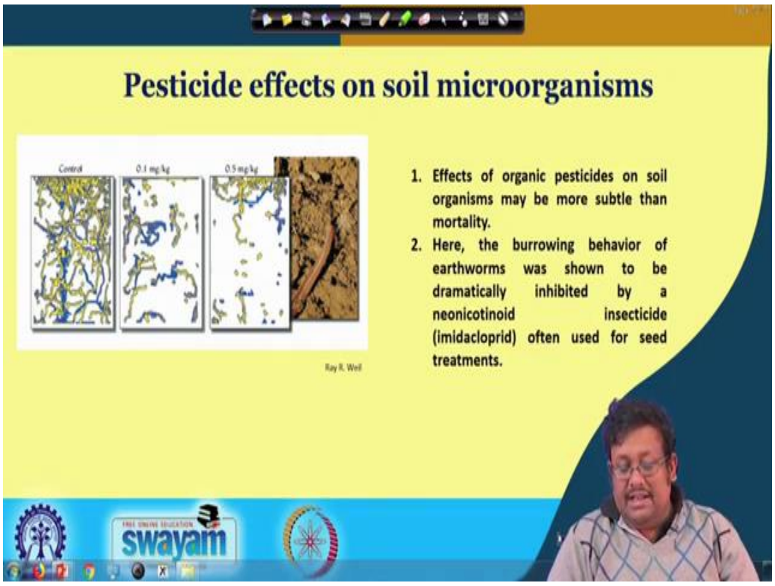

Not only ok, so what is the effects of pesticide in soil microorganism; obviously, the first effect is mortality when we are applying this pesticides that will kill the native microorganism. Apart from organic, you know mortality these effects of organic pesticides are also very subtle. For example, you can see here you know the burrowing behaviour of the earthworm shown to be dramatically inhibited by a neonicotinoid insecticide.

Here,there is no neonicotinoid insecticide is imidacloprid. So, when you are increasing, so this is a control condition this is an you know 0.1 mg per k g concentration where is 0.5 mg per kg. So, burrowing activity, behaviour of earthworm also reduced because their activity is reduced while we are increasing the different you know pesticide concentration in the field.

So, that shows the deleterious effects of increasing amount of pesticide effects. Obviously, pesticides are need for controlling the weeds and controlling the pests, but also they are having this type of you know desired you know deleterious effect.

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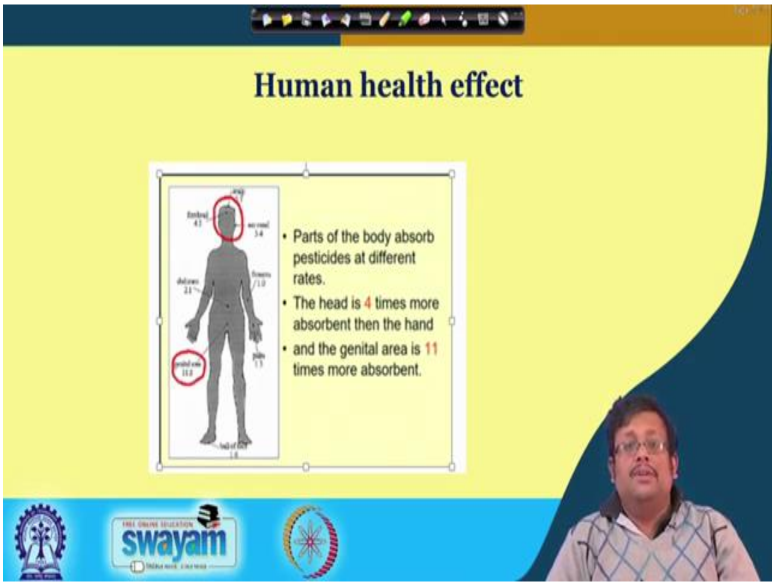

And finally, the human health effect is very very important and you can see parts of the body absorb pesticide at different rates and the head is 4 times more you know absorbent then that hand. And genital area is 11 times more you know absorbent. So, depending on the different parts, different types of symptoms of pesticides injection is there and as a result; obviously, due to the high amount of pesticide injection and high accumulation of pesticide in the different parts of the body, there are several types of non-curable diseases like cancer and other things are happening nowadays specifically in Punjab areas of India.

So, that is why we need to be very very careful while handling this persistent organic pollutants and organic pollutants into the field in the agricultural areas and I hope that you have learned something in this lecture. So, we are now finishing the week 9 lectures. All the five lectures and we will be starting the week 10 of lectures from the next lecture and we will be covering different ways to control this organic pollution as well as we will be discussing different types of inorganic pollutants in the soil.

So, thank you guys. Let us meet in week 10 lectures, bye.