Soil Science and Technology
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Lecture – 43
Conservation Tillage

Welcome friends to this third lecture of week 9 of Soil Science and Technology and in this lecture we will be covering this topic of conservation tillage in details. Obviously, we have conserved, you know, talk about the conservation tillage in our tillage lecture earlier in this course and we will be discussing in details about this conservation tillage and different ways in Conservation Tillage.

So, in this week you have already learned about soil erosion and land degradation. We talked about what is land degradation and how soil erosion takes place, what is the definition of soil erosion and, what are the different agents of soil erosion. We talked about water based erosion, their mechanics of water erosion and, different types of water erosion like, splash erosion then we talked about the sheet erosion and then gully erosion and then rill erosion. Remember that in the splash erosion is basically detachment of soil particles with the help of falling raindrops.

Because rainfall has a certain kind of an energy which ultimately detaches the soil particles from the big clods. And then, it moves away with the flow with the flowing water and ultimately it is moving a sheet of soil from the ground and which ultimately causes the sheet erosion. And then sheet and finally, water will move through small channels ultimately, you know, eroding all the soil particles, you know, this is called the rill erosion which are basically characterized by small channels.

This erosion you have, you know, rill erosion can be rectified using the cultivation of different types of, you know, different types of crops. However, the soil is lost and in the extreme form of erosion is called the gully erosion when the soil is permanently lost. Then we talked about different ways to control the soil erosion, we started with the check dams and we started and we talked about the contour cropping, contour strip, strip cropping and, you know, inter cropping, then crop rotation, then alley cropping, and then we talked about different conservation tillage and also.

And also we talked about how to calculate this erosion using the universal soil loss equation, and what are the different factors of soil, universal soil loss equation, how we can calculate those factors, We know, how if you remember rainfall erodibility factors, then the K factors and then length and slope factors, then management practice factor.

Support practice factors are all these factors. What are their importance and how we calculating them, and ultimately what is a revised universal soil loss equation, and how we can calculate that we showed you a side by, we know, a example where we used both soil universal soil loss equation as well as revised universal soil loss equation side by side to calculate the amount of soil lost.

So, in this conservation tillage will be talking about different, you know, different; different types of conservation tillage which generally is being practiced in different countries as well as in India. And also I will be showing you some trends, how they affect in different soil properties.

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So, the concepts which we will cover here are basically what is the conservation tillage, and their classification of the conservation tillage, then erosion control by conservation tillage and high finally, effect on different soil properties by conservation tillage. Remember that, conservation tillage is one of the important ways of preventing soil erosion. So, now a days, it has;it, it if this conservation agriculture or conservation tillage

is, you know, is getting wide publicity by different countries and different environmental agencies.

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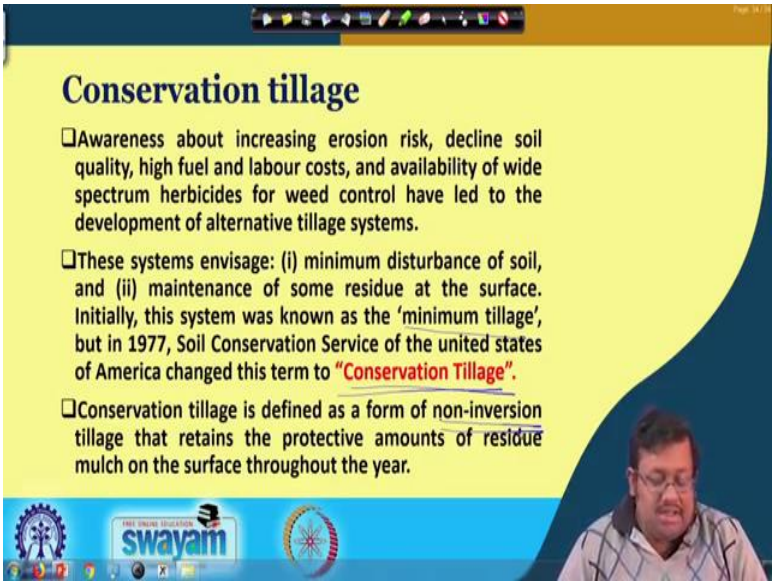

So, what is conservation tillage? So, remember that awareness about increasing erosion risk, decline soil quality, high fuel and labour cost, and availability of wide spectrum herbicides for weed control; all of these are, you know, have led to the development of alternative tillage systems. So, first of all the soil quality there is a continuous reduction in soil quality as a result of erosion. There is continuous increase in the erosion risk because of, we know, removal of organic carbon from the soil or organic matter from the soil. High fuel and labour cost and availability of wide spectrum herbicides for weed control.

So, all these ultimately are, you know, ultimately shows that, we need an alternative tillage practice or alternative tillage system than that of conventional tillage system because, now the tillage practice is becoming very very costly. So, these system basically envisage that minimum disturb disturbance of the soil. So, ultimately what is that alternate tillage practice? This alternate tillage practice is nothing but, the conservation tillage. And this, you know, this conservation tillage basically, you know, it basically envisage that it should create minimum disturbance of soil and maintenance of some residues at the surface and initially this system was known as the minimum tillage.

Remember that, initially we know this system was known as the minimum tillage. However, in 1977, Soil Conservation Service of USDA changed this term into conservation tillage. Because we are conserving a certain amount of plant residues or we know crop residues in the soil in this type of tillage operation.

So, conservation tillage is defined as a form of non inversion tillage that retains the protective amounts of residue mulch on the surface throughout the year. Remember that this is very important term non inversion; that means, in that general conventional tillage practices we invert the soil exposing the soil so, that all the, you know you know, the lower portion of the soil get exposed or the subsoil get exposed or the subsoil get exposed. So, we are basically the conservation tillage is a kind of non inversion tillage and ultimately it retains a protective amount of residue mulch on the surface throughout the year. How we will see.

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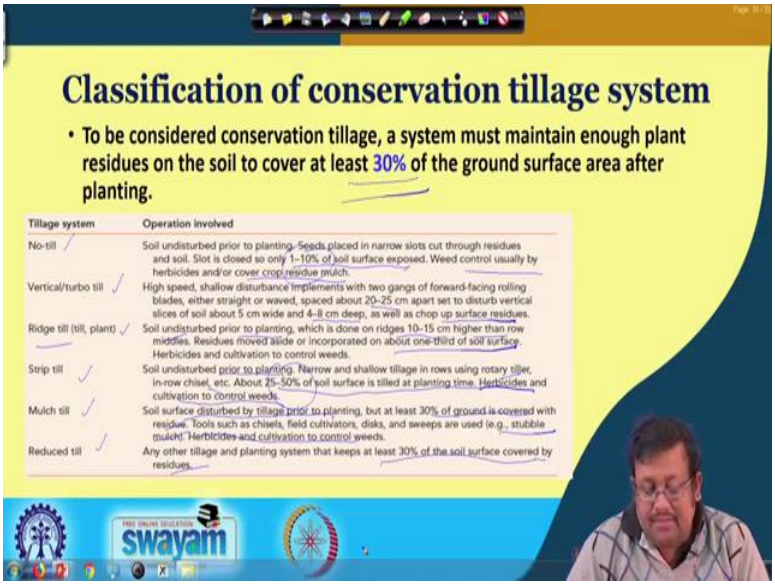

So, what is the classification of the conservation tillage system? So, to be considered as a consist of conservation tillage system, a system must maintain enough plant residues on the soil to cover at least 30 percent, remember that is a very very important term at least 30 percent of the cover soil cover has to be there on the ground surface after the planting. So, this is very important term. So, tillage system if you see what are the different types of conservation tillage there are around 6 types of different types of tillage system under

the conservation tillage we call it no till and then, vertical or turbo till, then ridge till, then strip till, then mulch till, and reduced till. So, let us discuss them one by one.

So, in case of no till practice; obviously, soil undisturbed prior to planting. So, we are, you know, we do not disturb the soil, and seeds placed in narrow slots cuts through residues and soil and slot is closed to only 1 to 10 percent of the soil surface are exposed. So, it is a very very less amount of soil surface is exposed, in case of conventional tillage most of the soil gets exposed or all of the soil get exposed. And; however, in this type of tillage when while we are exposing only 1 to 10 percent there is chance of weed infestation in the residues which are already left in the field.

So, weed control usually, you know, done by herbicides as and cover crop residue mulch. So, this is called the no till system we will discuss this later on. Another is called the vertical or turbo till and it is basically high speed shallow disturbance implement with two gangs and of forward facing rolling blades, and either straight or waved, you know, spaced about 20 to 25 centimetre apart set to disturb vertical slides of the soil about 5 centimetre wide and 4 to 8 centimetre deep, as well as chop up surface residue.

So, basically this turbo till helps in chop up the surface, you know, the surface residues as well as disturb vertical slices of the soil about 5 centimetre wide and 4 to 8 centimetre deep. So, this is called vertical where is called vertical or turbo till. So, it is a specialized instrument. Third one is called ridge till.

So, soil undisturbed prior to planting just like the no till system which is done on ridges to 10 to 15 centimetre higher than row middles, and you know you know, the ridge and furrow system you have must have seen the ridges and furrow system in the crop field. And residues move aside and incorporated on about one-third of the soil surface and herbicides and cultivation to control the weed. So, this called ridge till. The fourth-one is strip till system where soil is also undisturbed prior to planting and narrow and shallow tillage in rows using rotary tiller.

So, in the rows they we generally they generally perform narrow and shallow tillage using rotary tillers in row chisel etcetera. And about 25 to 50 percent of the soil surface is tilled at planting time and also herbicides and in cultivation to control the weeds.

So, you can see here, here 25 to 50 percent of the soil surface is tilled at the planting time in case of strip till. However, in case of no till system there is only 1 to 10 percent of the soil surface get exposed. So, mulch till is basically soil surface disturbed by tillage prior to planting, but at least 30 percent of the ground is covered with the residues of the previous crop.

So, tool such as chisel, field cultivators, disk, and sweeps are generally used example stubble mulch; basically, stubble mulch. So, after a rice crop whenever there is a field, we know, we go for sowing the wheat in a rice wheat cropping system, we, you know, retain the soil we retain the rice stubbles in the field. So, that it can cover at least 30 percent of the ground. So, these are example of mulch till and also herbicides and cultivation to we do the herbicide spraying as well as cultivation to control the weeds.

So, finally, reduced till any other tillage and planting system that keeps at least 30 percent of the soils surface covered by residues. So, you can see these are the 6 different way, you know, process under conservation tillage again; starting from no tillage system where the soil is undisturbed prior to planting and seeds are placed directly in the narrow slots cuts to the residues in the slot, and in this case only 1 to 10 percent soil is exposed as compared to the conventional tillage and obviously, when there is a only, we know, 1 to 10 percent soil is exposed rest of them are covered and there will be chances of infestation of different types of weeds and, these will be basically, controlled by, you know, herbicides as well as cover crop residue mulch.

In case of vertical till, again these are the specialized equipments which creates the cuts in vertically in the soil and ultimately chopping the residues and also ridge till basically, it soil is again undisturbed prior to planting and which is done on ridges to 10 to 15 centimetre higher than row middles. And the strip till also of the same, you know, the same, soil is undisturbed prior to planting. And 25 to 50 percent of the soil surface is tilled at the planting time below at the narrow and shallow tillage in rows is basically done using the rotary tiller and also here we are using herbicides and cultivation to control the weeds.

Finally, mulch weeds, you know, soil surface disturbed by tillage prior to planting and 30 percent of the ground is covered with the residues. I gave an example of rice seed cropping system and how we, we are covering we are creating the stubble mulch. And

here also we are using the herbicides and cultivate cultivation to control the weeds. And; finally, reduced till which is any other form of conservation tillage or any other tillage system that keeps at least 30 percent of the soil surface covered with this system.

So, guys this very important slide and try to remember the differences between this 6 different practices under conservation tillage, which will be helpful in your exam. And these are each of these are having their own benefits and these are very much effective for reducing the soil erosion.

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So, let us see side by side the example of conventional tillage versus conservation tillage. You can see the left picture shows the conventional tillage conventional tillage system and the right picture shows the conservation conservation tillage system. So, in the conventional inversion tillage a system you can see a mouldboard plough, you know, inverts the upper soil horizon, just like here you can see the upper soil horizon is getting inverts. So, burying all the plant residues and producing a bare soil surface.

So, when you are using in the conventional tillage a mouldboard plough, it is basically inverting the whole soil and ultimately, you know, mixing the residues, you know, burying all the plant residues and producing a bare soil surface, and when there is a production of the bare soil surface; obviously, it is a chance of more erosion. And here, in the right side you can see this in conventional tillage practice, where you are using a chisel plough, and 1 type of conservation it is a basically 1 type of conservation tillage

implement. And it basically, stirs the soil, but leaves a good deal of crop residues on the soil surface it is. So, it is a chisel plough. So, it is a, it is cultivating the soil, but at the same time it is, you know, it is leaving a sizable amount of residues over the soil surface. So, this is the difference between conventional tillage and conservation tillage or inversion tillage and non inversion tillage.

In the definition of the conservation tillage, we talked about that the conversion convention conservation tillage is a kind of non inversion tillage. So, you can see here basically in the convention in the conventional tillage we are, you know, burying all the residues. However, in the conservation tillage, we are keeping the residues at the surface we are not burying them into the directly into the field. So, that they can, we know, reduce the soil erosion and also produce some other beneficial effects.

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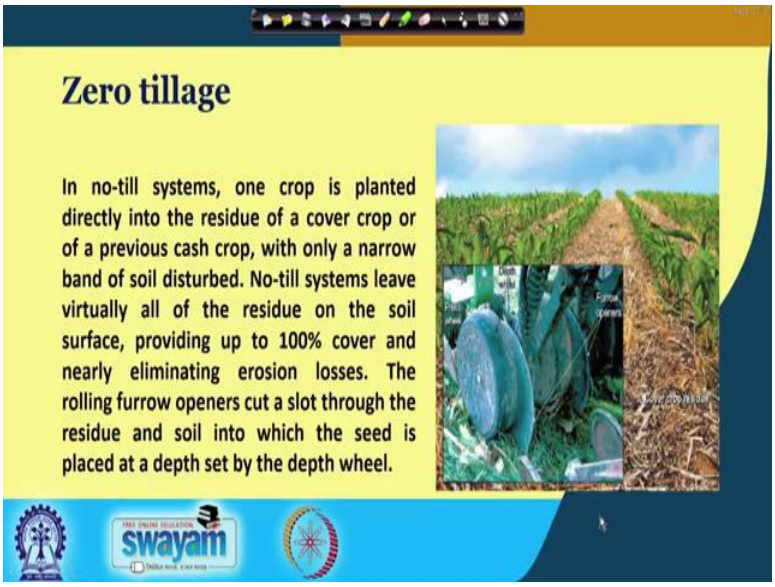

So, zero tillage we talked about zero tillage system. So, in no till system one crop is planted directly in the residue of a cover crop or a previous cash crop with only a narrow band of soil is disturbed, we know, you remember 1 to 10 percent is of the soil is basically disturbed.

So, no till system leave virtually all of the residues on the soil surface providing up to 100 percent cover and nearly eliminating erosion losses, because all the soils are covered. So, there is, you know, literally no chance of removing or eroding the soil because there is no bare soil surface. So, the rolling furrow opens openers basically cuts

a slot through the residues and soil into the into which the seed is placed at a depth set by the depth wheel.

So, you can see here this is basically, we know, zero tillage and here you can see there is a depth wheel which is maintaining and, you know, which is maintaining the depth of the seed placement and it basically open these are furrow openers which opens the furrow. And, we know, and ultimately pushes the seed at a particular depth. And these operation basically, you know, you can see this picture the zero tillage is basically done directly over the residues of the previous crop.

So, we are not inverting the soil, we are not mixing the residues, we are not burying the residues, we are directly placing the seeds in small furrows created by this instrument and we are directly placing the seeds directly over the when the 100 percent of the soil is covered by the previous crop residues.

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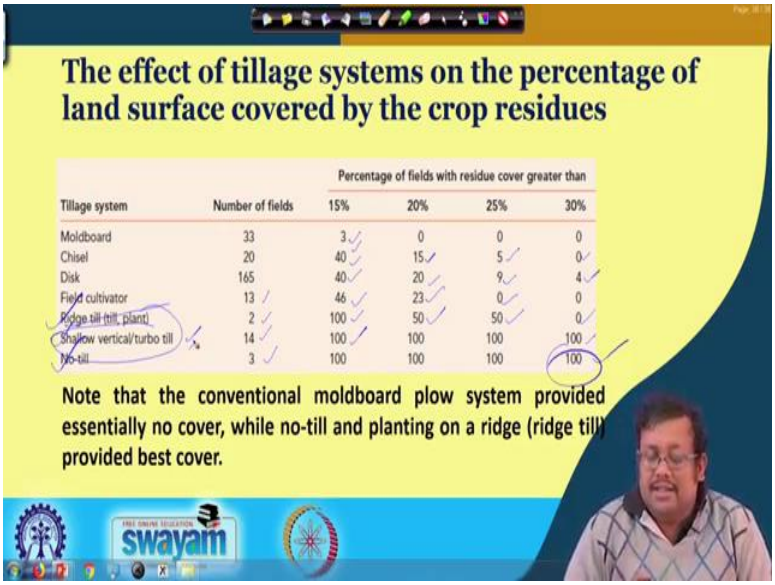

So, this is what we call zero tillage system. And then, let us see the effect of tillage system on the percentage of land surface covered by the crop residues you can see here just, you know, we have taken this example from a research study. So, you can see here the number of fields in case of mouldboard with 33 chisel was 20 and in case of disk where we consider 165. In case of field cultivator, there was only 13 we talk, you know, we considered. And in case of ridge till that is 2, in case of shallow vertical turbo till we consider only 14, in case of no till we consider third.

So, let us see the percentage of field with residues cover greater than and 15 percent 20 percent 25 percent and 30 percent. So, in case of mouldboard system mouldboard tillage system you can see the percentage of field with residue cover greater than 15 percent is only 3 ok. So, percentage of field with residue cover greater than 15 percent is only 3, and in case of chisel if greater than 15 percent is 40 and.

So, 40 percent of the field are having, you know, cover greater than 15 percent and then 15 percent of the field are having cover greater than 20 percent and 5 percent of the field are having cover greater than 25 percent whereas, no field are having greater than 30 percent of the cover. So, again in case of mouldboard plough only 3 percent of the field are having residue cover greater than 15 percent and none of the field are having greater than 20 percent or 25 percent or 30 percent field cover. In case of disk, you know, based system 40 percent of the field are having residues cover for greater than 15 percent, 20 percent of them are having residue cover greater than 20 percent.

And only 9 percent are having cover greater than 9 percent, and only 4 percent are having, you know, cover greater, you know, residue cover greater than 30 percent. And then field cultivator, in case of field cultivator 46 percent are having greater than 15 percent of residue cover, 23 percent having greater than 20 percent of field cover, 0 percent whereas, no ,you know, there is no field cover beyond 25 percent.

In case of ridge till or till plant you can see 100 percent of the of the field are having greater than 15 percent residue cover, 50 percent of them are having greater than 20 percent of residue cover, 50 percent are having greater than 25 percent of the cover. However, none of them are having greater than 30 percent, in case of shallow or vertical turbo till, you can see 100 percent of having, you know, shallow vertical or turbo till, you know, 100 percent of the field are having residue cover greater than 30 percent.

Because we are keeping all the residues just by chopping them using this vertical or turbo till. So, we are maintaining most of them in the over the soil surface, and in case of no till you can see; similarly, we are caving 100 percent which is above 30 percent. So, you can see note the conventional mouldboard plough system provided essentially no cover while no till and planting on a ridge till provided the best cover.

So, also, we know, so, this is very very important this ridge till system and this no till system is also very very important, and also this shallow, vertical and turbo till is also

important. However, we are not considering because these has some disadvantages we will consider that in a couple of slide.

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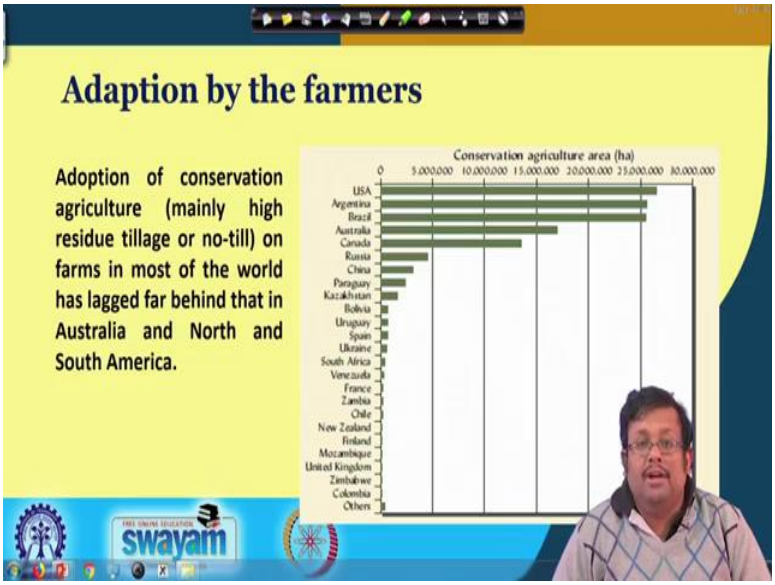

So, what are the adaptation of these technologies by the farmers? So, while we are talking about since long time about the utility of this convenes conservation agriculture and how it is importance specially in Indian scenario we need to know about the, we know percentage, of its adoption, because that is important. So, you can see this an adaption of conservation agriculture mainly high residue tillage or no till on farms of most of the world has lagged far behind than in, that in Australia, North and South America.

So, you can see here, the conservation agriculture, you know, area wise it is highest in you know in USA followed by Argentina, Brazil and Australia and then Canada and, we know, some amount in Russia and China. However, in some other place, you know, Paraguay, Kazakhstan. However, you can you cannot see a, you know, a name of India in this list.

So, the adaption by of these improved system of this improved cultivation technology or alternative cultivation technology by the Indian farmers are lagging far behind, and that is why we need to as an agriculturalist, we need to emphasize the need of this conservation tillage to our farmer. So, that they can not only the maintain the inherent soil fertility, but also they can help in reducing the soil erosion and also help in resisting

the soil degradation. This is very becoming very very important as, you know, as there is a continuous decrease in soil productivity in many areas of Indian sub continent.

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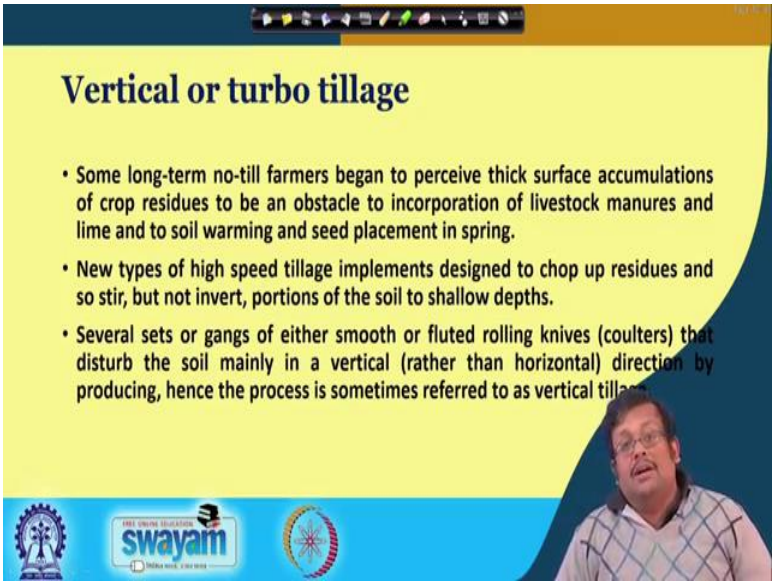

And so, we talked about, you know, vertical and turbo tillage.

So, some long term on no till farmers began to perceive thick surface accumulation, you know, of crop residues to be an obstacle to incorporation of live stock manures and lime and to soil warming and seed placement in spring. So, how this concept of turbo till and vertical in a vertical or turbo tillage, you know, evolves those farmers we which are performing long term no tillage practice. They thought that, do you know when there is a, you know, continuous thick surface accumulation of accumulation of residues, because they are not removing those residues.

They can put an obstacle in the, to incorporation of the livestock manure, because that is also important we are also advocating the integrated nutrient management where we are supporting the incorporation of different types of livestock manures and also sometime lime application for, you know, and to soil warming and seed placement in spring. So, that is these are very very, you know, these are getting problematic.

So, the new type of. So, that is why a new type of high speed tillage implement designed to chop up the residues and to stir, but not invert the portion of the soil to shallow depths. So, that is why this turbo tillage concept came, and there are, you know, in these

machine the turbo tillage machine there are several sets of gangs of either smooth or fluted rolling knives or coulters, we call them coulters.

And these basically disturb the soil mainly in a vertical rather than horizontal direction by producing hence the process is somewhere referred to as the vertical tillage. Remember that that is why we are calling it vertical tillage because it is chopping up or it is basically disturbing the soil or stirring the soil vertically.

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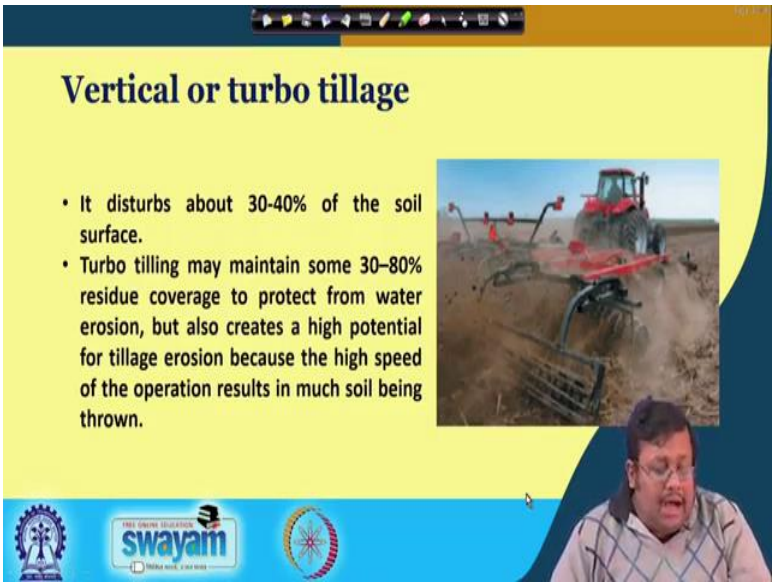

So, it disturbs basically 30 percent to 40 percent of the soil surface and turbo tilling may maintain some 30 to 80 percent of the residue coverage to protect from water erosion, but also creates a high potential for tillage erosion because the high speed of the operation results in much soil being thrown away.

So, you can see here these a turbo till and as a result of this turbo tilling, you know, a huge amount of, you know, soil particles are being carried, you know, are being basically thrown away and basically, these also can, you know, can cause the potential soil erosion so, this very, very important. So, that is why, you know, turbo tillage is considered sometime are not beneficial.

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So, let us consider one of the major issues nowadays in Indian scenario.

So, if you go to different places of India, you will see that burning of straw and air pollution, which burning of straw of different, you know, different residues. So, it is now become a, you know, very important topic from Indian, you know, from Indian environment point of view. Because, you know, the farmers in several states several stage they you use to burn their residues after the cultivation because they think that carrying cost of this, you know, or processing cost of this residues are carrying cost of this residues to one place to another place is not economic.

So, what they do? They just burn away these residues and as a result of that a huge amount of, you know, air pollution, you know, huge amount of particle generates and smoke generates which ultimately creates huge air pollution. And these air pollution effect is very much see, you know, prominent in our capital region of New Delhi which is creating, you know, at these air pollution is creating a huge amount of smog, you know, which has been in the news for last couple of years.

So, to prevent this environmental air pollution, we need to think about some alternative management practices.

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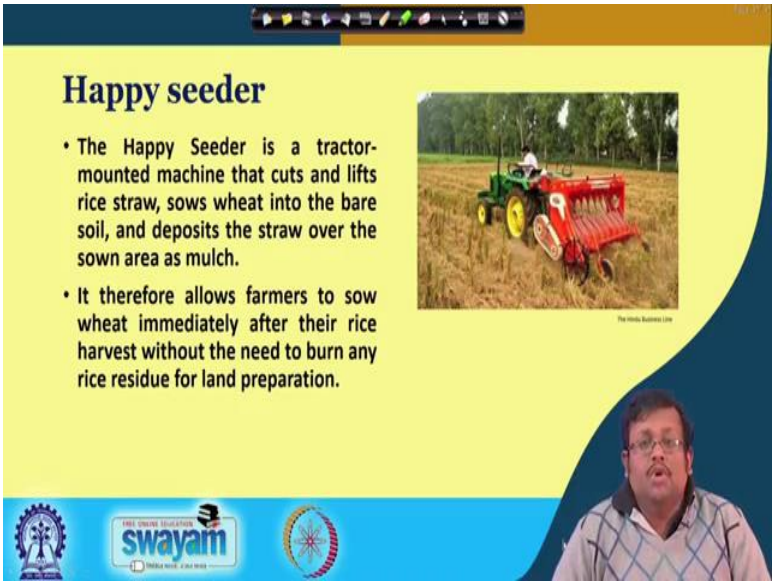

So, we need to we need to we need to consider some alternative ways so, that we can better manage this residues. So, that is why a new instrument came, that is called happy seeder, you can see this is an happy seeder. So, this happy seeder is a tractor mounted machine that cuts and lifts the rice straw and sows wheat into the bare soil and deposit the straw over the sown areas much.

So, it therefore, allows farmers to sow wheat immediately after their rice harvest without the need to burn any rice residue for land preparation. So, that is the importance of, you know, this conventional tillage, I am sorry conservation tillage and this conservation tillage can be done, you know, in a you know in a better, better way using this happy seeder and this happy seeder can help in directly, you know, sowing the wheat into the bare soil and deposit depositing the rice straw over the sown over the sown area as mulch there by removing then removing the chances or removing the, you know, necessity to burn the rice residues

So, this conservation tillage can also be. So, the purpose of showing you the happy seeder is happy seeder could be a, you know, could be a decided, you know, can be a deciding tool for removing these air pollution, you know, which is being created from this burning of these crop residues in several steps. So, this is a, you know, helping in conservation tillage. So, guys let us wrap up this lecture and in the next lecture, we will be trying to finish this conservation tillage.

And then we will be starting different as starting discussing different aspects of wind and tillage erosion and I hope that you have learned several things in this lecture, and we have discussed in details about the conservation tillage. And let us discuss more in our next lecture of week 9 until then.

Thank you.