Forests and Their Management
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Module – 07
Silvicultural Management – I
Lecture – 21
Clear Felling System

[FL] Today, we carry forward our discussion on Silvicultural systems and in this lecture, we will have a look at the clear felling system.

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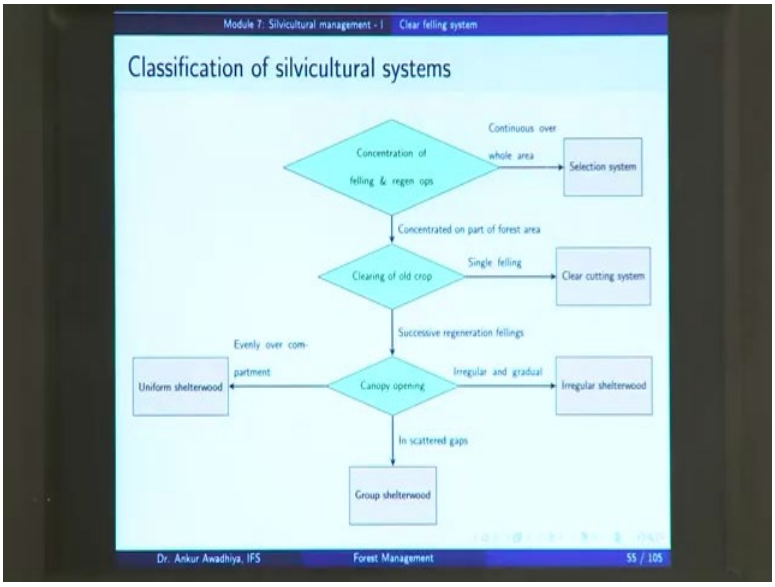

Now, if you go through this flowchart, this is the clear-felling system. So, what are the characteristics of a clear-felling system? The first question that this flowchart asks is, what is the concentration of felling and regeneration operations? So, in the case of a clear-felling system, it is concentrated in part of a forest. You do not do the felling and regeneration operations over the whole area, but it is concentrated in on certain parts of the forest.

So that is one characteristic, and then the clearing of the old crop is done in a single felling. So, the whole of the of the old crop in that concentrated part of the forest area will be felled in a single felling. So, these are the two characteristics of a clear felling system.

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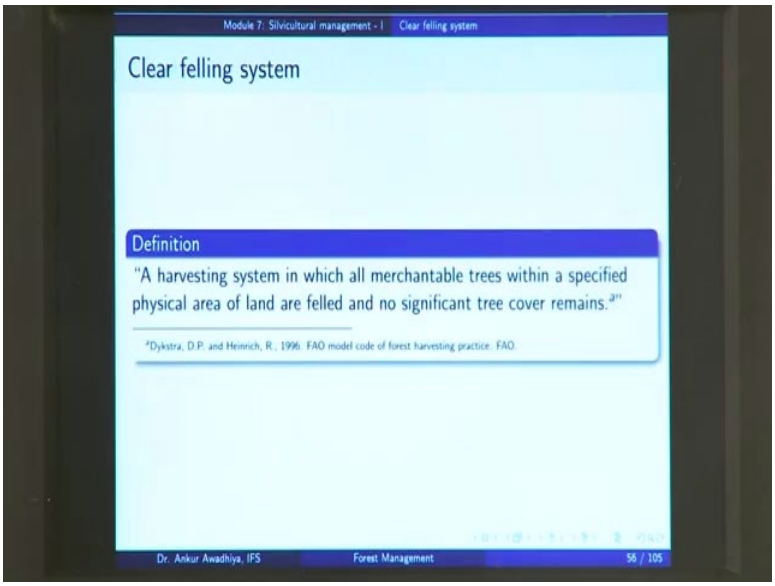

So, we define a clear felling system as, "a harvesting system in which all merchantable trees within a specified physical area of land are felled and no significant tree cover remains." So, it is a harvesting system; it is a system in which you are felling trees and removing the timber, or you are harvesting these trees. And, this is the system in which all the merchantable trees; now what are merchantable trees? These are those trees that have a sufficient diameter or girth and height as to be economically useful.

So, you can sell these trees; these trees can be traded. So, these are known as merchantable trees. And in this system, all the merchantable trees within a specified physical area are felled. So, it says that the working is concentrated, and everything that is in the specified physical area of land where you are concentrating your operations; all the merchantable trees are felled and no significant tree cover remains; which means that, you would you would remove all the canopy and there is no canopy that remains.

So, a clear felling system is a harvesting system in which all merchantable trees within a specified physical area of land are felled and no significant tree cover remains.

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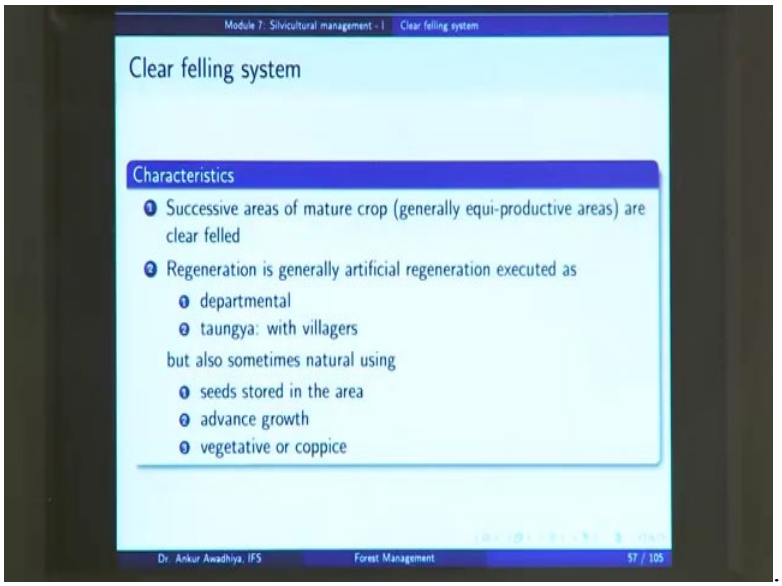

So, what are the characteristics of this system? The first characteristic is that successive areas of mature crop, generally equal - equi-productive areas, are clear felled. So, what it is saying is that, you take an area and you clear fell that area, then you go to another area, clear fell the mature crop in that area; then you go to the third area, clear fell it; then you go to the fourth area, and so on. Now, these areas are taken to be equi-productive areas. Now what is an equi-productive area?

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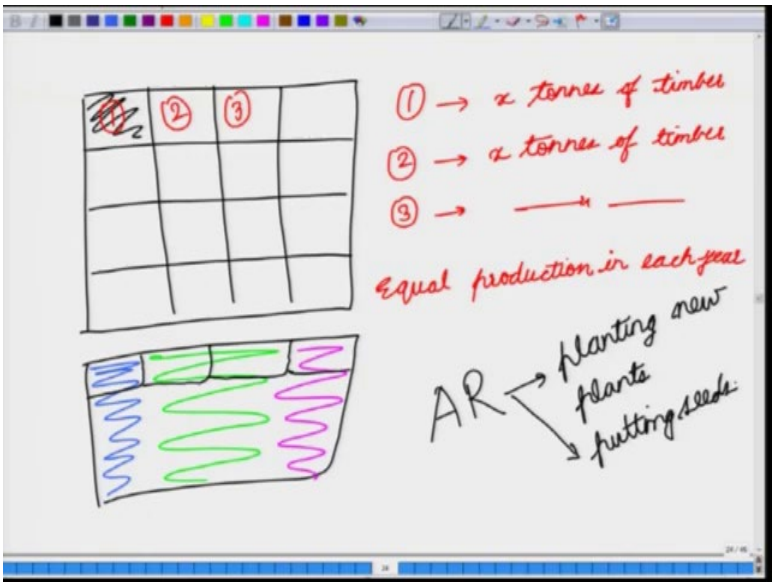

So, suppose this is your forest. So, you divide it into a number of small parts where you will be concentrating your efforts. And, you will concentrate your efforts or you will choose these areas in a way that, if we look at site 1; so, in the first year, you are working on the first site and suppose you get ‘x’ tonnes of timber. Then, in the second year you move to site number 2. Now, in this thicket, in the second year also you should be able to get ‘x’ tonnes of timber. Then when you go to the third site again, in the third site, you should be able to get ‘x’ tonnes of timber; which means that there is an equal production in each year.

So, suppose, you have a situation in which, this section is the most fertile; this section is less fertile, and then this section again has a greater amount of fertility. So now you will choose your equi-productive areas in a way that, here because you have a greater density, so, you take a smaller area; and in this section, you take a larger area. And, then here again you take a smaller area, so that in every year, you will be getting the same amount of production.

So, you concentrate your working in the clear felling system in such a way that you are working on an equi-productive area and you are getting the same yield every year. So, the first characteristic is that successive areas of mature crop generally, equi-productive areas are clear felled.

Now, if you are doing a clear felling; so, there are no more trees that remain in that area; there is no more canopy that is remaining in that area. So, what will happen to the seeds? So, you will not be getting new seeds in that area because you are not leaving any trees. So, in most cases, the regeneration, in the case of a clear felling system, will be through an artificial regeneration.

So, you will be making use of AR, in which case, you will be planting new plants or other way - you can be putting seeds into this area. So generally, the regeneration is artificial regeneration, and you can do this artificial regeneration in two modes; you can do a departmental regeneration. Or, you can do a taungya regeneration, in which case, you give this area to villagers, so that they are able to raise some agricultural crops. But at the same time, they have the responsibility of regenerating the forest as well. So generally, the regeneration is artificial regeneration done either in a departmental mode

or done in in collaboration with the villagers. But at times, we also find that we use a clear fell felling system; but we go for a natural regeneration.

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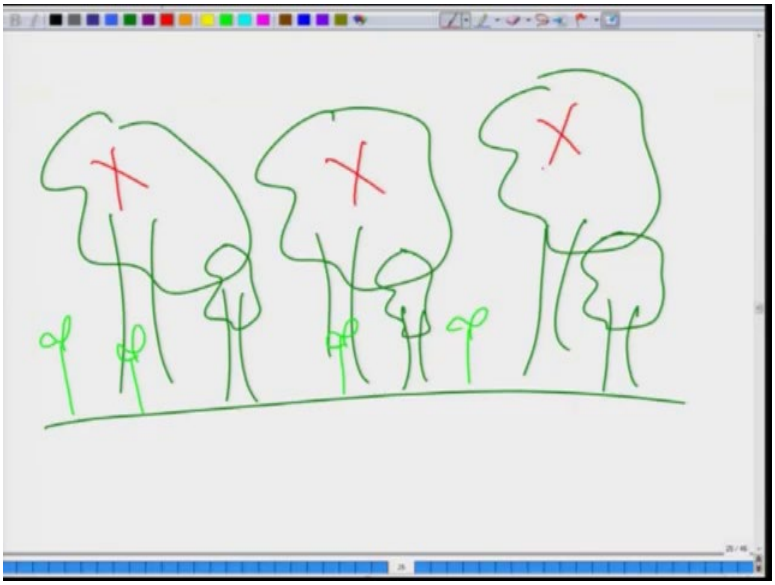

Now, how can you have a natural regeneration? You can have a natural regeneration, because; suppose, these are the large merchantable trees that are there in your forest, but then when you are coming into the forest to cut these trees, then these are not the only trees. Because, there will be a number of non-merchantable trees; there will be a number of seedlings that are there in this area - the young crop, advanced growth, pole crops.

So, when we come into this area, we will find that there are a number of seedlings in this area. Or, there are some other trees of the same species, but they have not reached a merchantable height. So, these are the small trees, and they have not received sufficient time to become completely mature trees.

So, in this case, when we do a clear felling, we remove these large sized trees; but once we have removed them, there are still trees that are left and these trees will continue the natural regeneration.

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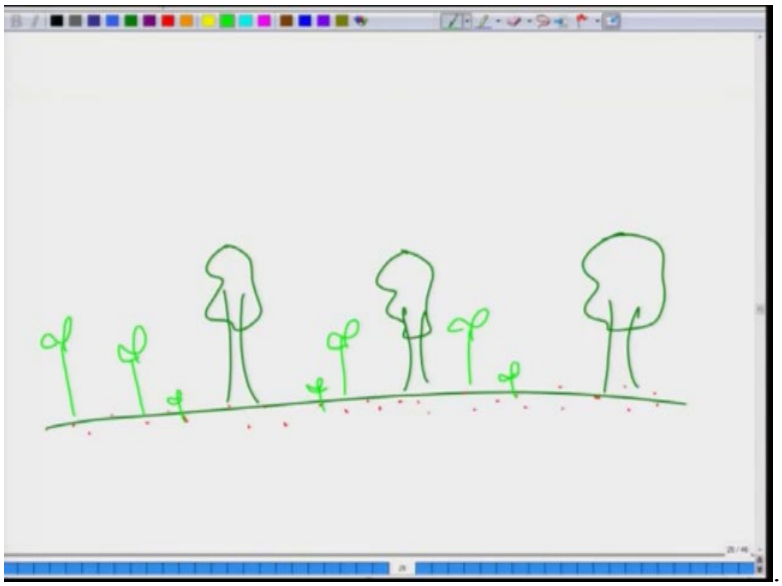

So natural regeneration is the regeneration, in which we are not doing any planting, we are not throwing seeds from outside, but the crops that have come up on their own; they regenerate the forest. So, in the case of clear felling, there is also a possibility of natural regeneration. The second option is that of coppicing.

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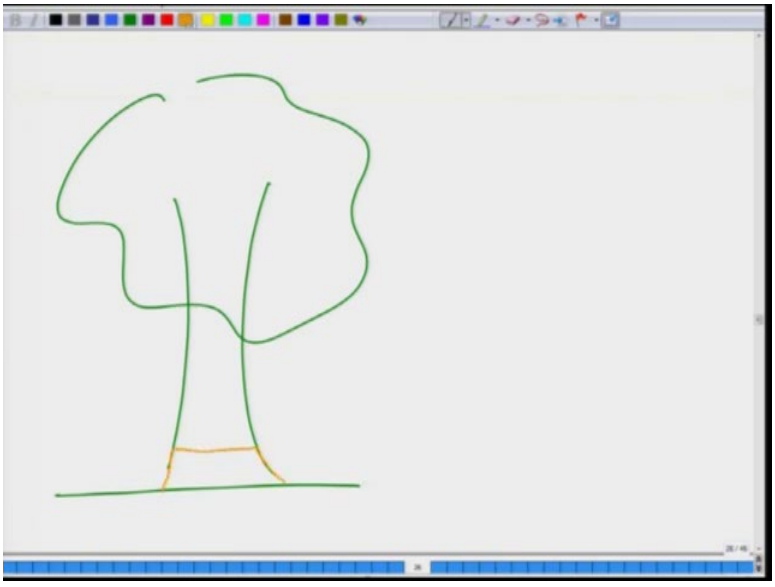

So, suppose you have this tree, and in the clear felling system, you remove this tree.

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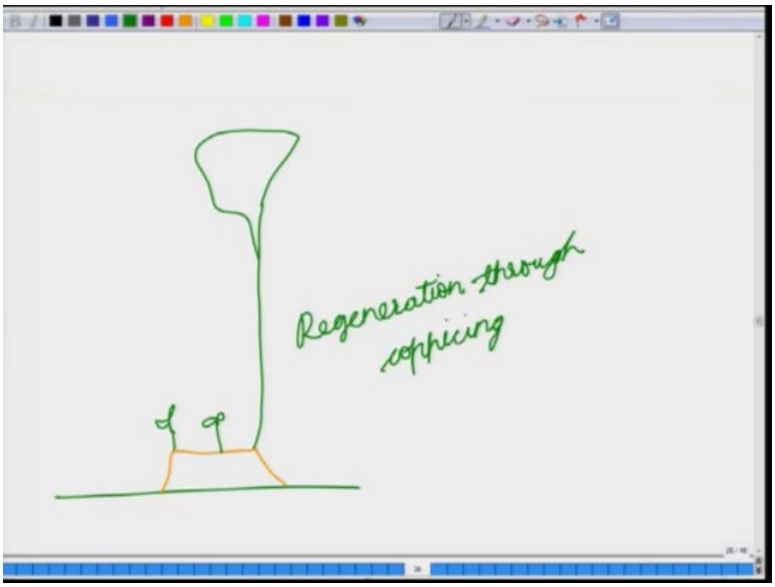

So, you cut this tree so that only this stump remains and you have removed the other portions. Now after a while, this stump will give out a shoot or probably a number of shoots, and one or more of these will later on grow and become the tree.

So, this is regeneration through coppicing. Now, coppicing is a vegetative mode of propagation. So, you are not putting in a new individual; the same old individual gave out a new shoot, and it became a tree once again.

Another way in which you can have a natural regeneration in clear cutting is, because when we talk about the forest float, there could be a number of seeds that were there in this area. And, not all the seeds have germinated in the last season. So, the soil will act as a seed bank and there will be a number of seeds that are that are lying there on the forest floor. So, with time, probably these will give off some new seedlings.

So, there will be natural regeneration because of the seed bank. Also, there could be natural regeneration, because of other modes of vegetative propagation, such as root suckers. So, in the case of clear felling, you have regeneration that is either artificial regeneration or sometimes natural regeneration using seeds stored in the area, advanced growth, vegetative propagation or coppicing.

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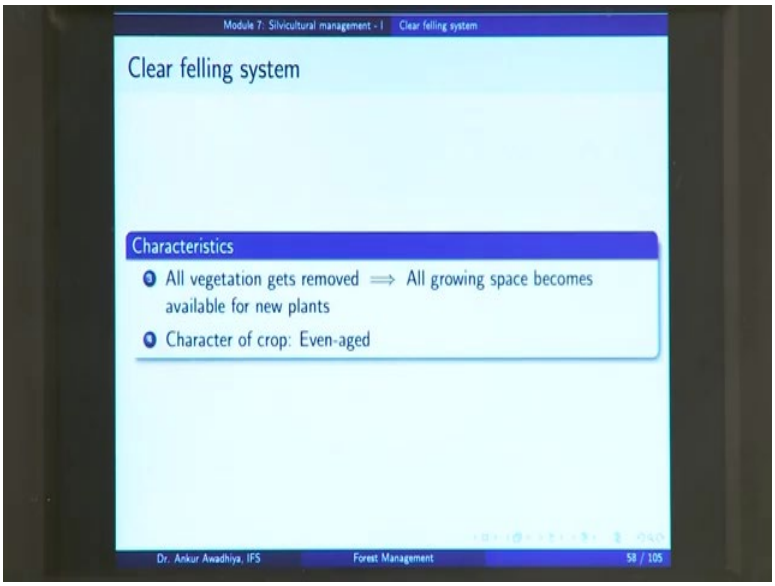

Another characteristic of the clear felling system is that all the vegetation gets removed and all the growing space becomes available for the new plants. So, in the case of the clear felling system, there is no competition whatsoever, from the previous generation of trees. So, this is as against a shelterwood system, in which there are some trees that remain or that are left in that forest. And, these trees are also using the same sunlight, the same water, the same nutrients that could have been made available with the new crops.

But here, because you have removed all the trees of the previous generation, so all the growing space - 100 percent of it, becomes available for the young crop. Now, the character of the crop that comes up is even-aged for forest.

Now, why is it even-aged? Because all these trees are coming up at the same time, and the differences between their ages is typically less than 20 percent of the rotation age. So, you will be having an even-aged forest that gets formed.

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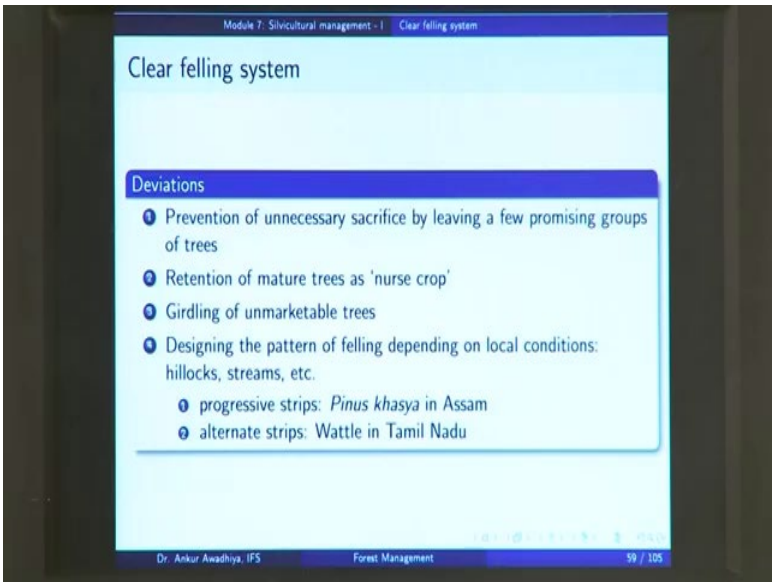

Now, at times, clear felling system is also used with certain deviations. So, these deviations could be prevention of unnecessary sacrifice by leaving a few promising group of trees.

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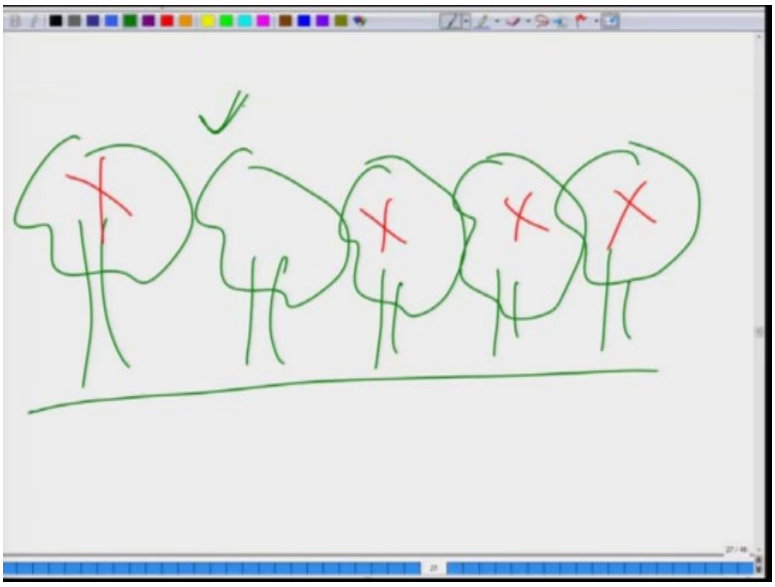

So, what we are saying here is that, you had this forest and you are managing this forest using a clear felling system; but then probably the market is down, probably you do not require that much amount of wood or timber. So, you might say that, “ok, I am going to

use a clear felling system, but I do not need so many trees to be felled;" so, why do not I leave a few trees?

So, in that case what you will do is, you will cut these trees, but you let this tree remain on the site.

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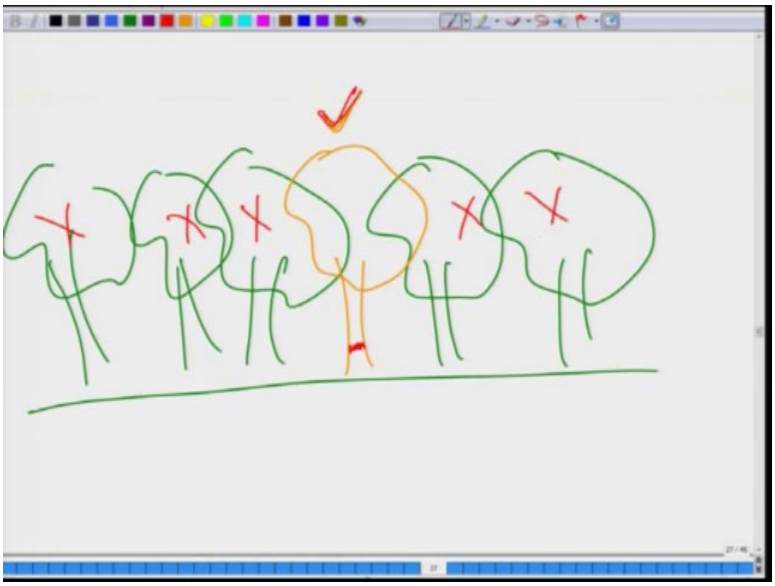

So, after a while this will be the situation: so, all these trees have been removed, but one tree remains. Now, this one tree you are not leaving it because, it is providing shelter, you are leaving it, because it is a promising tree, and probably you can come back to this site and later on, cut it.

So, this is one deviation. At times, people go for a try to prevent the unnecessary sacrifice by leaving a few promising groups of trees. Or at times, people might retain a few mature trees as a nurse crop, in which case, this system will tend to move towards a shelterwood system.

So, but in the case of a shelterwood system, you are leaving the shelter trees across the forest, but in this case, people might just say, "Ok, let us leave a few trees here. They will provide shade; they will nurse the young crop." So, this is a deviation that we generally find in the clear felling system.

Or, people might go for girdling of unmarketable trees. So, in this case, people might say that, ok, this this is the forest to begin with, and here you have a tree of another species.

Now, some person might say that, “Ok, I need to do a clear felling, but then this tree - the yellow tree is not a marketable tree. I cannot sell it in the market. So, why should I spend my time and energy and money to cut this tree, and take it outside of the forest? Why do not, I do this thing that I will just girdle this tree near the base.”

So, I remove the bar and I disrupt the vasculature of this tree; so, invariably in a short time this tree will die. But then, I leave this tree here on the side. So, I cut all these trees, but I do not cut this particular tree; I just girdle this tree and I let it remain in this on the site.

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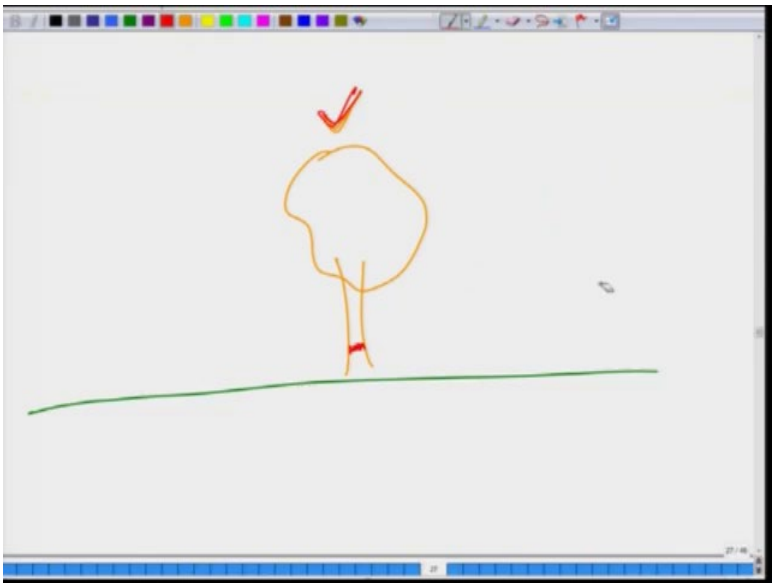

So, the other growing space has been made available; but this tree after a while, it will lose its canopy, there will be only a few branches that are left.

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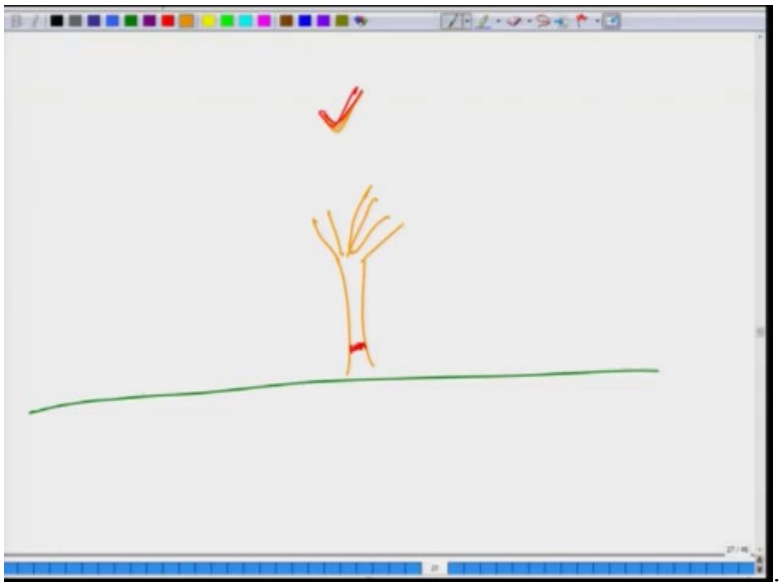

So, this tree is not using up a lot of my sunlight; this tree is not using water; it is not using nutrients, because it's a dead tree. So, why should I spend my time and effort and energy and money to take it out? So, I will just leave it here.

So, this is another deviation that we generally see in the case of a clear felling system; girdling of unmarketable trees. Another deviation is designing the pattern of felling depending on the local conditions such as hillocks, streams etcetera.

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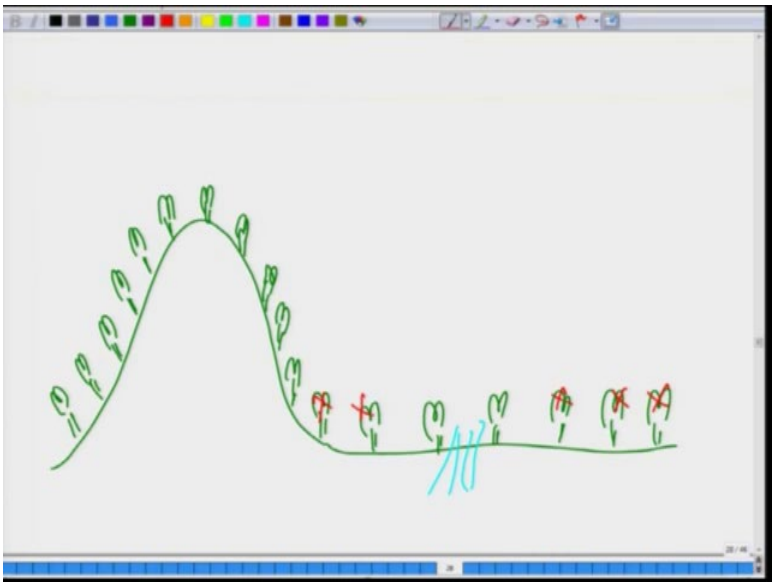

What we are saying here is that, suppose you have a hill and this hill is all full of trees, then you have this plain area. And, your forest is in this undulating land, and probably you also have a river that is flowing here.

So, this is an area with the rivers. Now, at times, you might say, “Ok, I need to manage my forest in it with using the clear felling system.” But then, if I do a clear-felling on the mountains; on the hills, then probably that will lead to a huge amount of soil erosion. So, let me just leave the hills as such. Because, in any case, it will take me more on amount of time, energy and resources to cut these trees in the hilly areas.

In the plains, it’s easy to work. But in the hilly areas, it becomes difficult. So, why do not I leave those trees? Similarly, when we talk about that the trees that are there on the banks of the river, they are also stabilizing the riverbanks. Why do not I leave those trees as well?

So, in that case, what I will do is I will remove these trees; but I will remove, but I will retain the trees that are there on the hills; and, I will retain the trees that are there on the riverbanks. So, now the situation becomes something like this.

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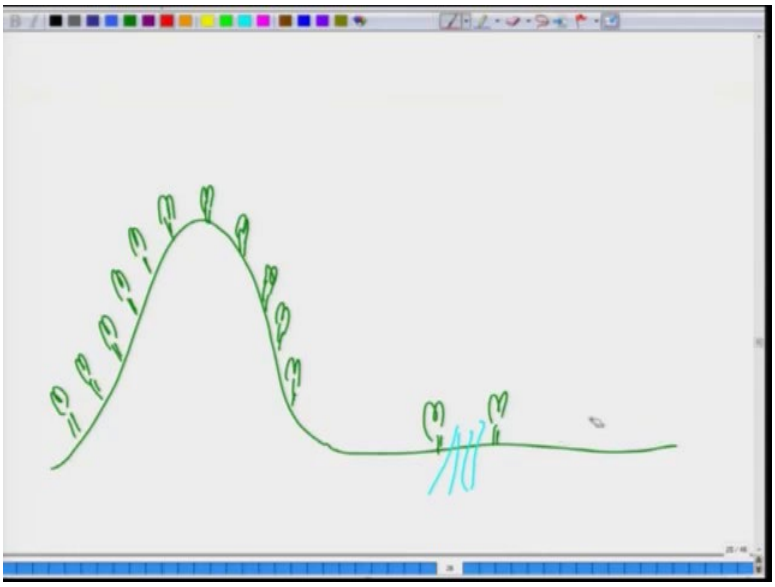

So, I am making use of the local conditions; I am keeping them in my consideration and I am changing the clear felling system, based on the local conditions. So, this is also another deviation that we generally find. Or, at times, people might do this clear felling

in the form of progressive or alternate strips. Now, why would somebody want to do it in the form of a strip?

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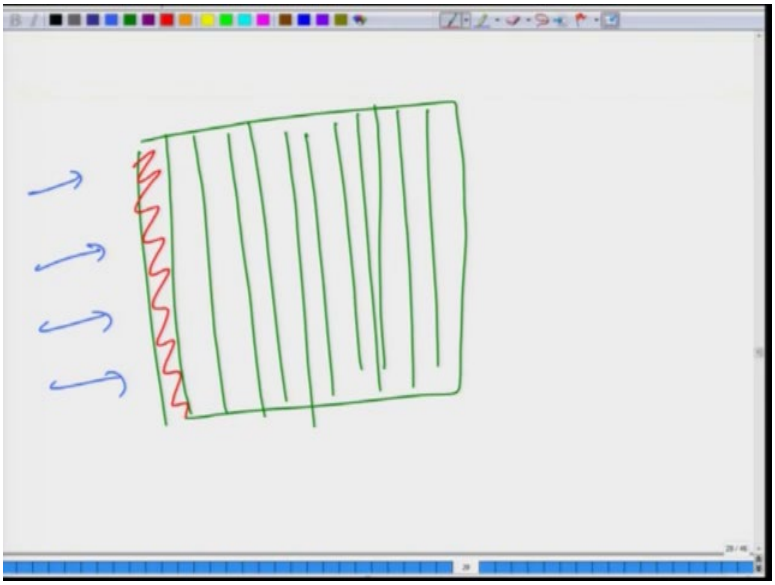

Because, suppose this is the forest and the prevailing wind direction is this. So, I might say that in when that when I am doing a clear felling in this area, in that case, the amount of wind that will be flowing it over the land will be too high, and it will be desiccating the soil or probably even eroding the soil.

So, why do not I do my clear felling in the form of strips? So whenever I am denuding any strip, even when I am denuding the first strip, what is happening is that there is only a small amount of land over which the wind is blowing, and typically, when we do this strip clear felling, we do it against the direction of the wind.

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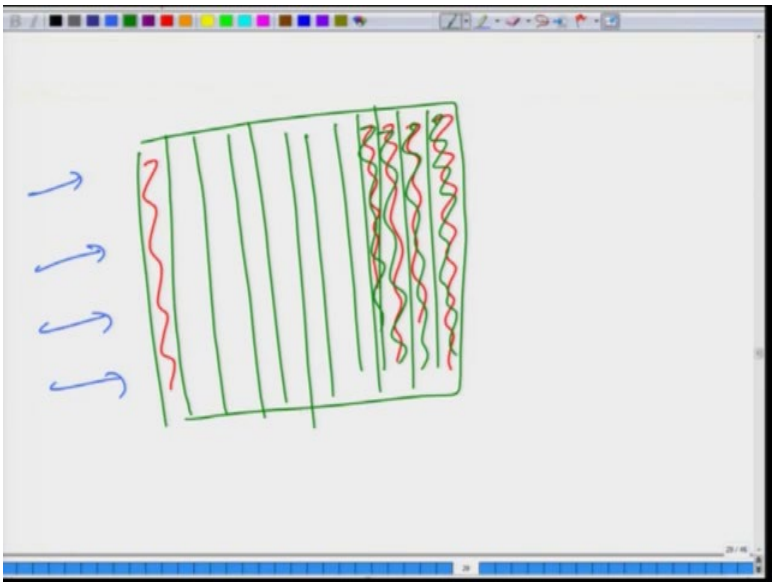

So, first of all, I will do my clear felling in this area, because in that case the trees that are here; are going to protect the land. Then, next year, I will do the clear felling here. Next year, I will do the clear felling in this strip. After that, I will do it in this strip and by the time I reach this strip, these areas have already regenerated in the form of forests.

So, this is another deviation that people make use of. You can go with progressive strips, in which case, you do one strip after another strip or you can go with alternate strips.

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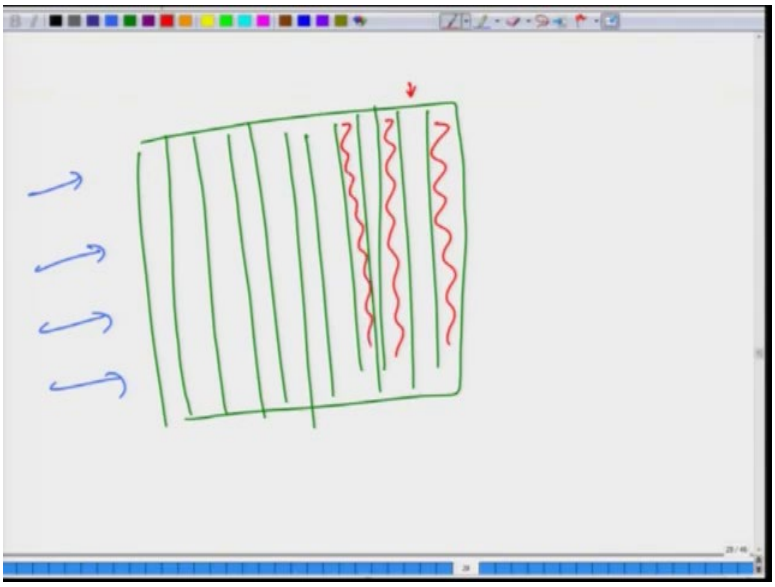

So, in the case of alternate strips what we will do is that, in the first year, you have clear-felled this area. Now, in the next year, you will leave this strip and you will clear fell this area. In the next year, you will clear fell this area. So, why are we doing this? Because the wind speed is so high that, if we clear-felled all the strips one by one, in that case, the amount of soil erosion because of the wind will be too high.

So, these are the kinds of deviations that we generally see in the case of the clear felling system.

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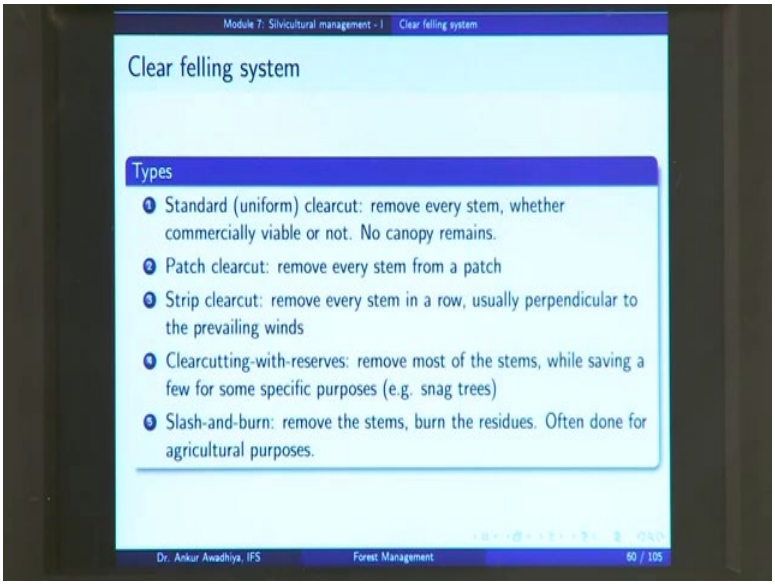

Now, there are different types of clear felling systems.

You can have the standard or the uniform clearcut system, in which case, you remove every stem whether it is commercially viable or not, and no canopy remains. So, this is the most traditional or the most standard form of clear felling. You remove all the trees no matter what species; no matter what size, so that the whole of the growing space becomes available. And, once you have removed all the trees, you will probably go for planting of the new generation. So, the regeneration will be through an artificial means. So, this is the most standard way of doing the clear felling.

Otherwise, you could go with a patch clearcut. So, you are removing every stem from a patch. So, you are doing it patch by patch, because probably your forest is so large that you are unable to clear the whole area in one go.

Or, you could go with a strip clearcut, in which case, you remove every stem in a row usually perpendicular to the prevailing winds as we just saw.

Another type is clearcutting-with-reserves, in which case, you remove most of the stems, but you save a few for some specific purposes, such as snag trees. Now what are snag trees? Snag trees are old trees in which you have certain hollows, in which birds or other animals can make their home.

So, you are managing your forest with a silvicultural objective. You want to harvest timber out of it, but there are also wildlife and you need to take care of the wildlife. So, you do a clear felling, but you retain a few trees for this specific silvicultural objective of wildlife management.

So, this is known as clear cutting with reserves, because you are reserving a few trees and you are not cutting them. Another type is the slash-and-burn clear felling. Now, in the slash-and-burn clear felling, you remove all the stems and you burn the residues. So, in this case, you do not let anything remain on the on the piece of land.

So, you have removed or whatever was merchantable, and whatever remains that is the twigs, the branches, the leaves, you burn them all. And, this is a very extreme form of deforestation, and is generally done when you are converting your forest into an agricultural field. So, you do not want to have any biological residue that is remaining in that piece of land; you remove everything by burning. So, these are the types of clear felling system.

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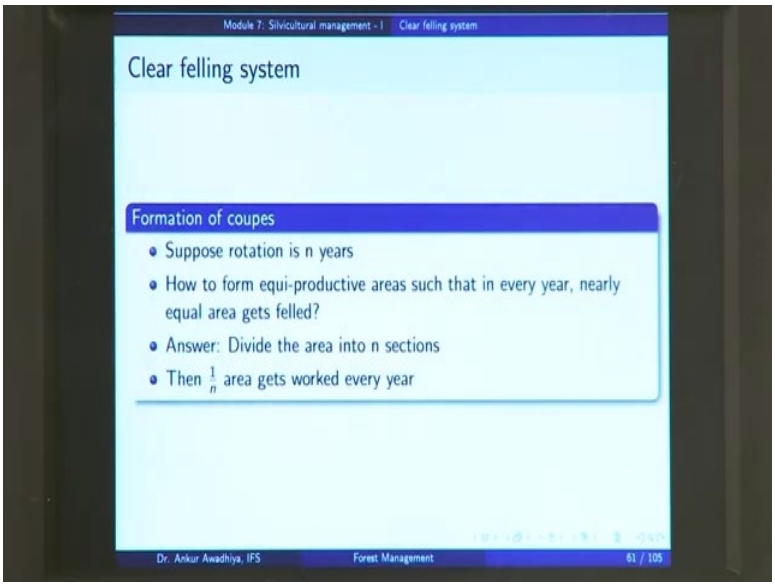

Now, when we talk about a clear felling system, we also have to talk about the coupes. Now what is a coupe? Suppose your forest is a very large forest, and you cannot work in each and every area of your forest in the same year. It will take you multiple number of years to clear fell your forest. So, how do you organize your management or your operations in a way that every year you have some work to do. Every year you are getting some revenue out of the forest; every year you are getting some produce from the forest; how do you ensure that?.

So, suppose the rotation; so, we begin by looking at the rotation age of the crop. Now, rotation age is the age at which your tree becomes mature for felling. Now, let us take a simple example that you are growing eucalyptus. Now, a eucalyptus tree generally takes 6 to 7 years to reach maturity, and at the age of 6 to 7 years, you can cut your eucalyptus trees and sell them in the market, probably for the making of plywood.

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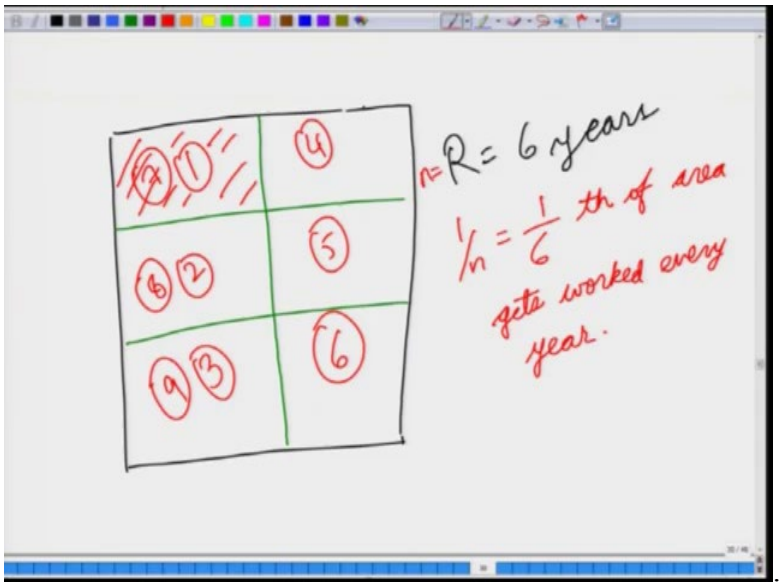

So, suppose, your rotation period is or R is 6 years, and this is the forest that you have. So, what do you do? You can divide your forest into 6 equal parts. So, here you have 6 equal parts in the forest, and you work on 1 part in each year. So, in the first year, you will be felling this section, in the second year, third year, fourth year, fifth year, sixth year. Now, at the end of the sixth year, the first section has now regenerated and you have trees that have reached the rotation age; they have now become mature for felling once again.

So, in the seventh year, you will again move back and fell the section, that you fell the coupe that you had felled in the first year. Then, in the eighth year, you fell this one; in the ninth year, you fell this one, and so on. So, if the rotation age is 'n' years, then how do you form the equi-productive areas such that in every year nearly, if nearly equal year gets felled. You divide the whole area into 'n' sections and one by nth of the area gets worked every year.

So, in this case; so, you have 'n' is equal to - r is equal to 6 years. So, 1 by n or 1 by 6 of area gets worked every year. So, this is the formation of coupes. Next have, let us have a look at the suitability of the clear felling system.

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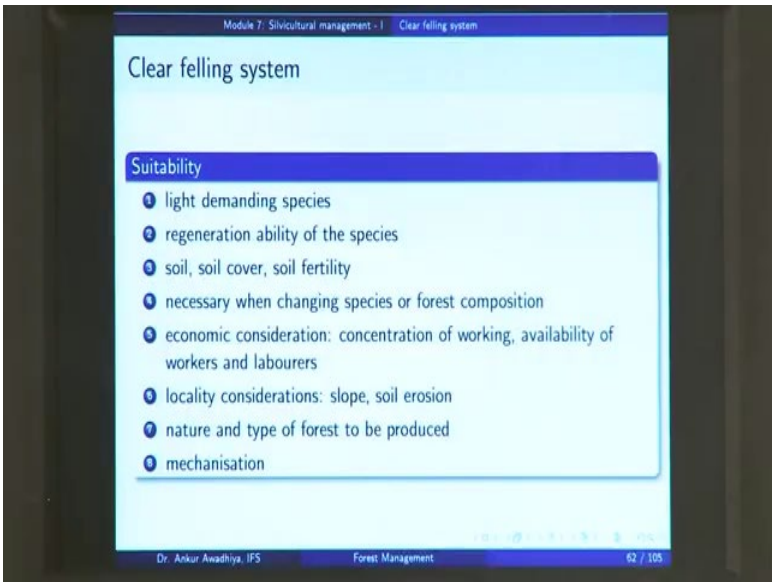

When do we use a clear felling system? It is suitable only for light demanding species. If you have a species that is unable to tolerate intense light, in the early stages of its growth, in that case, you cannot go with a clear felling system, because once you have removed the canopy, the intense sunlight is going to kill off your young generation.

So, it is only applicable for light demanding species. You will only use it for those species where you can you are assured of the regeneration ability of the species. Because you have, if you have cleared up the whole area, and you tried to regenerate that area, and the regeneration did not come up; in that case, because of desiccation; because of soil erosion, you could have a situation in which the whole of the area has now become unproductive.

In which case, we will call it a forester's folly. So, to avoid a forester's folly, you will only use it in a species where you are sure that this species will be able to regenerate in the stipulated time period. When you are using a clear felling system, you need to consider the soil, the soil cover, and the soil fertility of the area.

If the area is such that, you have a very small amount of soil or the soil is not fertile enough, then probably when you do the clear cutting, the regeneration will not come up and this area will become barren. So, the soil conditions and the soil fertility have to be ensured; have to be checked, before you are using a clear felling system. It is very much necessary when you are changing species or the forest composition.

So, for instance, you have a forest that is a mixed forest and you want to convert it into a teak plantation. And, you want to convert it into a teak plantation, so that you can extract timber out of it, and you want to completely convert it from a mixed forest into a teak plantation.

So, in that case, a clear felling system might be recommended, because you will be removing all the trees, and you will be planting those trees that you want to have in the forest. So, whenever you want to have a change of species; a change in the composition of the forest, clear felling system can be resorted to.

Clear felling system is also suitable when you look at the economic considerations. The working is concentrated, and if you have sufficient number of workers and laborers that are available, when you are doing the clear felling, then you can go with this system. Because, whenever you are doing the clear felling, you will have to do the regeneration in a short period of time.

So, only when you are sure that you will be getting the workers; you will have new - you will be getting the laborers; you have enough money to pay them, then you will go for a clear felling system. Then, locality considerations have to be kept in mind, if the area is very sloppy; if the area is prone to soil erosion; then, probably you will not go with the clear felling system. Because once you have exposed the soil, it will very easily get eroded especially in the sloppy areas, and especially in areas that have large winds large rainfall.

Then, nature and type of forest to be produced is something that you will have to keep in mind; because, suppose you want to retain an area as a natural habitat; suppose you want to have natural looking aesthetics of the forest; you want to have a forest that looks like a natural forest, if you go for it with a clear cutting system, then because it produces in even-aged forest, all the trees will look one and the same and it will look very artificial.

So, that the kind of forest, the nature of forest that needs to be produced will determine whether or not you will go with the clear felling system. Then, the amount of mechanization is also a factor that determines the suitability of the system. Because in the case of clear felling, it is generally advisable to go with large machines, so that you can clear fell the area in a quick manner, and you can remove a large amount of forest produce.

In this case, you are not talking about removing one or two trees from here or there, you are talking about the removal of a large number of trees. So, in this case, mechanization is not only advisable, but it is also imminent to be used in certain areas. So, do you have those machines? Do you have large size trucks? Do we have large size harvesters? will determine whether clear felling system can be used in your area or not.

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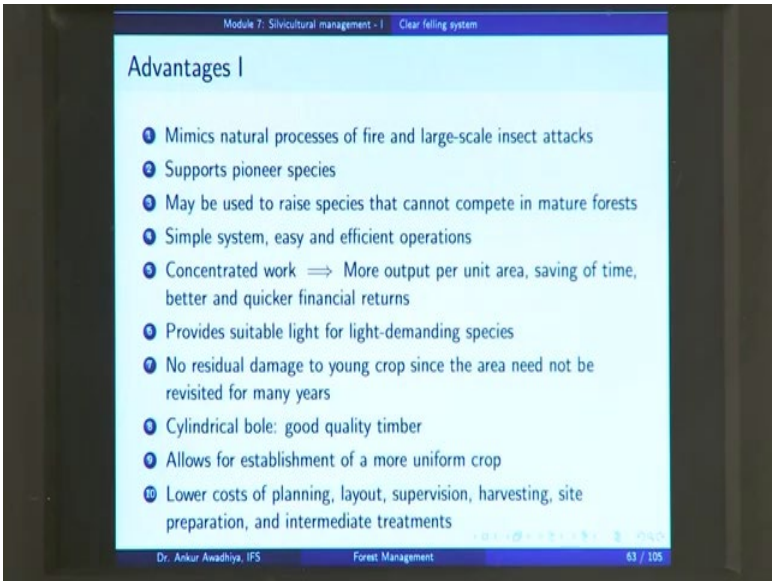

So, let us now have a look at the advantages of this system.

The first advantage is that it mimics the natural processes of fire and large-scale insect attacks. So, when you have a forest fire, the whole of all the trees in the forest are burnt; they get burnt. Or, for instance, when you have a large-scale insect infestation, all the trees die-off. Now, your clear felling system is trying to mimic nature in these forms. So, the kind of forest that will come up after a large-scale forest fire or after a large-scale insect infestation will be an even-aged forest, and that is the sort of forest that you are producing in the case of a clear felling system. So, you are mimicking some natural processes.

And so, if you want to support pioneer species or if you want to raise certain species that cannot compete in mature forest, then you can go with a clear felling system, because probably your the plants that you want to raise are those that are unable to compete with the mature crops.

So, in that case, when you remove all the other trees, and you only grow your desired species. They will be able to thrive. Also, it is a simple system. There are easy and efficient operations you do not have to have a large amount of skill; you do not have to train the workers a lot. They just have to go to the forest and cut, each and every tree.

One of the simplest of managerial operations. It is simple; it is easy. The operations are efficient. There is a concentration of work. So, when you are talking about a certain area that needs to be clear felled, all the activity will be there in that particular area. So, you will be cutting all the trees; you will be loading them into trucks you will be transporting them from that area. So, all the work gets concentrated, and when you have a concentration of work, then management becomes easier; management becomes economical. You have more output per unit area; there is a saving of time and, better and quicker financial returns, because everything is happening very fast. You do not have to visit the area again and again; you just go there once you harvest all the timber and you have your returns.

So, it is a concentration of work that provides better and quicker financial results. It proves it provides suitable light for light-demanding species. This is one of the best systems that you can have, in the case of light-demanding species, because there is no canopy. All the resources are now made available; all the light is made available; all the growing space is available. So, it provides a suitable light for light-demanding species. There is no residual damage to young crop, since the area need not be visited or need not be revisited for many years.

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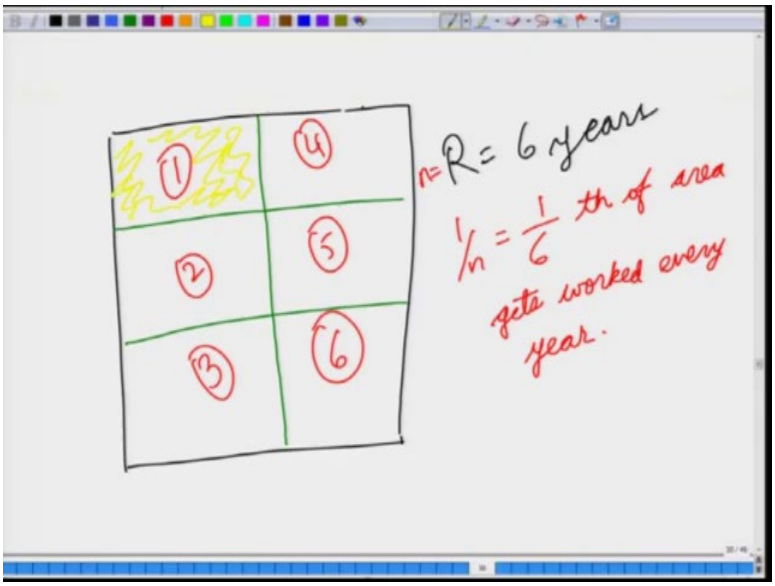

What we are saying here is that suppose, you are working in these coupes, so you have worked the first coupe, and so, you will revisit this area only after 6 years. So, in these 6 years, the crop that the young crop that came up in this area has ample time to turn into mature trees. You are not revisiting this area again and again, so that you want to cut a few more trees.

If you revisit this area, if you are bringing in machines again and again, then there would have been a chance that your young crop will get destroyed. They will get trampled upon or when you are removing the timber for harvesting; and if there is a young crop, then during the dragging operation of the timber. It is possible that the young crop might get adversely affected.

But, in the clear cutting system, because you are not revisiting these areas again and again; so, there is a lesser chance that your young crops will be damaged. So, there is no residual damage to the young crops. You typically get cylindrical bole and good quality timber. Why do you get a cylindrical bole? Because there are a number of trees that are now competing for the same growing space.

So, you have the young crops and all of them are competing against their own pairs and so, each of them wants to tends to increase in its height so that it is able to gain the maximum amount of sunshine. So, because of this competition, you will have trees that become long and that have a lesser amount of taper. All and they also have a lesser

amount of taper, because each of these trees is protecting each other from the wind pressures.

And so, according to Metzger's theory, there is a lesser requirement to put more more of the materials at the base. It allows for establishment of a more uniform crop. The crop is very uniform; it is very even-aged. Then, there are lower costs of planning, layout, supervision, harvesting, site preparation and intermediate treatments.

Because the operation is very simple, you go to the site cut off all the trees, harvest all the timber, then make pits, put up your new plants, end of it. So, you do not have to have a large amount of planning, layout, supervision, site preparation and so on. So, things become easy and because of that they become cheaper.

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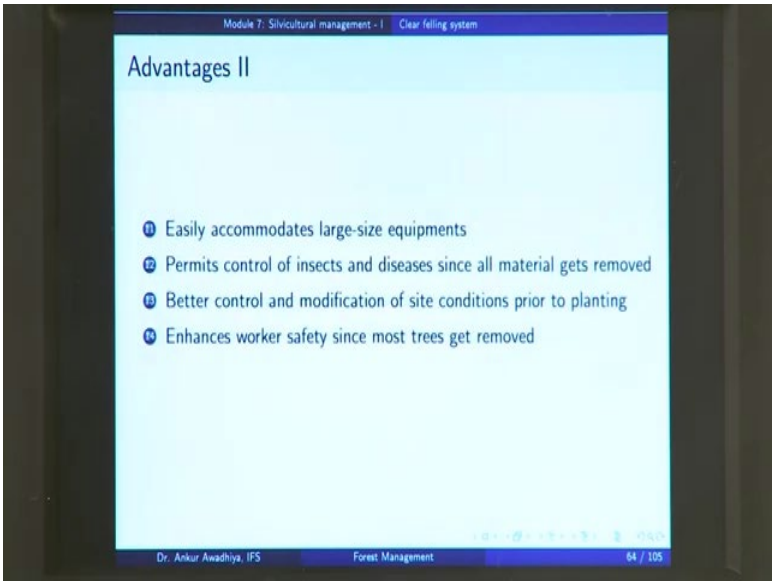

It easily accommodates large-sized equipments.

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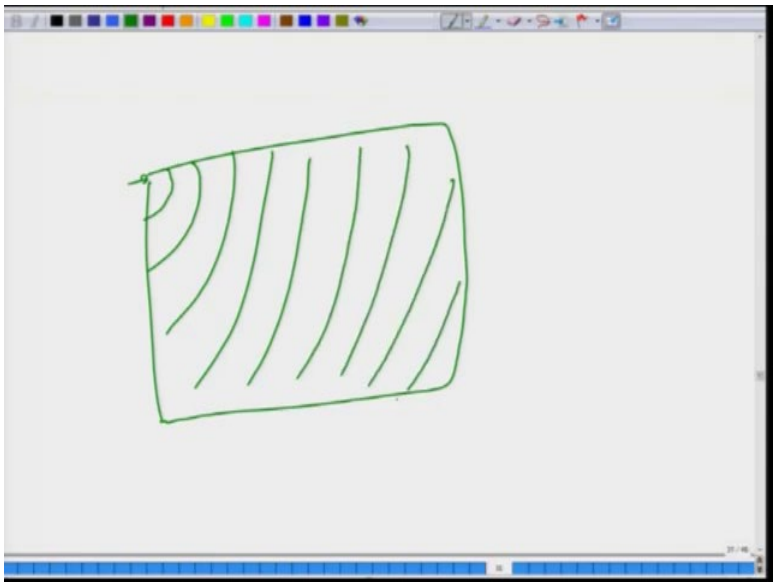

Because, when you talk about a forest and if you have a large size equipment, so you can begin from one end. You cut this area, then you cut this area, then you cut this area. And so, because you do not because you are you have to remove each and every tree, so it becomes easier for your equipment to get inside the forest.

Because, if there is any tree in the front, you can very easily cut that tree and remove it, so that there is a space that is made available for the entry of your machines. So, it easily accommodates large-sized equipments. It permits control of insects and diseases, since all the material gets removed.

So, in the case of a clear felling system, you do not leave any tree; you do not leave any diseases; you do not leave any parasites that could have been residing in that particular tree. So, in that case, if you have any insect infestation, if you have any diseases, and if you go with a clear felling system, you have removed all the trees; and so, there is no pathogen or no pest that remains in this area.

So, it is a very good method, if you want to control diseases or pests or insects. There is a better control and modification of site conditions prior to planting. Because you have an open denuded area, in which you have to perform your planting operations; so, you can do whatever you want to do. You can bring in tractors; you can bring in augers, and there is a much better control and modification of site conditions that you can do.

Then, it also enhances worker safety since most of the trees get removed. You are not entering into this area again and again for 1 or 2 trees. So, the worker safety is enhanced to a very large extent because to towards the back of the workers there is no tree that is left.

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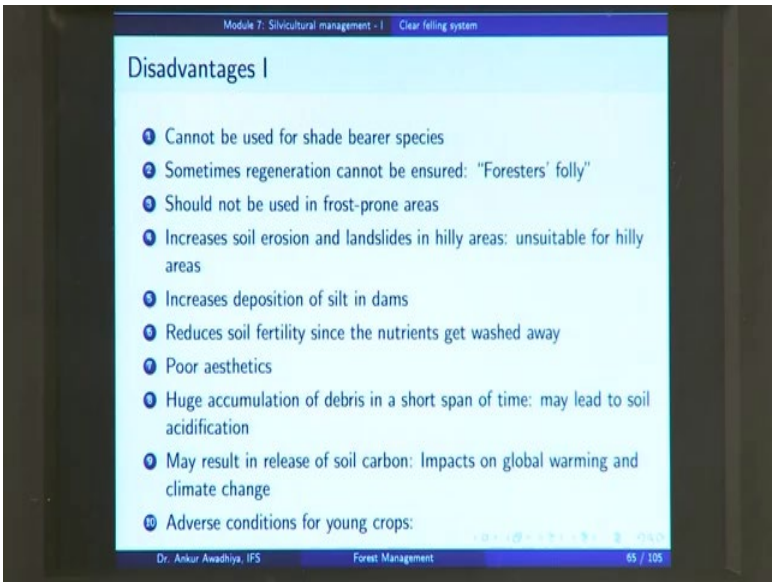

However, the system also has certain disadvantages. You cannot use it for a shade bearer species. So, a shade bearer species is one that requires shade in the early phases, especially in the early phases of its life. So, because you remove the complete canopy, so there is 100 percent intensity of sunshine that gets into this area, and if your species is a shade bearer species, then the plants will die off. So, this clear felling system cannot be used for shade bearing species.

Sometimes regeneration cannot be ensured; so, which might lead to forester's folly. So, in the case of other systems such as the shelter wood system or the selection system, you leave trees in the area. So, at all times your forest looks as if it has a number of trees, and it looks like a forest. But in the case of a clear felling system, suppose, you have removed all the trees and you were not able to regenerate the area, so in that case, this whole area will look denuded. It will look very ugly and people will say that you have committed a forester's folly or a forester's mistake.

It should not be used in frost-prone areas, because your young crops are completely exposed to frost. There is no mother tree to protect them against frost. You cannot use this method in the frost-prone areas.

Then, it increases soil erosion and landslides in the hilly areas. And so, it is unsuitable in hilly terrains. Because if you have a sloppy area, you remove the tree cover; the soil is exposed; there is any amount of rainfall and the soil will get eroded. So, you cannot use it in hilly areas.

It increases the deposition of silt in the dams. Because, when the soil gets eroded where will it go? It will it will reach to the nearest river through the channels, and from there it will reach one of the other dams; and then, it will result in silting of the dams. So, if you have a dam in the vicinity, probably, you should not go with a clear felling system.

It reduces soil fertility, since the nutrients get washed away. Because it is exposing the soil, the soil is made barren. So, in that case, if there is any rainfall, then the nutrients will also very easily get washed away.

Then, there is a poor aesthetics. In the case of clear felling system, because you have a forest which will have a patch that does not have any trees, it looks very bad. There is a huge accumulation of debris in a short span of time and this may lead to soil acidification. Because, what you are doing in a clear felling system is that, when you are removing all the trees in this area; so, the timber is removed, but then and a lot of the debris is also generated in this area. So, you will be having small branches, small twigs, lots of leaves that are not merchantable, that you are not removing from the site. So, what will you do with those? You just leave them on the site, and when you leave them on the site; they get decomposed. And, when they get decomposed that will also lead to the production of a number of organic acids. And so, the soil may get acidified. So, it leads to acidification because of in the huge accumulation of debris.

Then, it may result in release of soil carbon which has impacts on global warming and climate change. So, when we talk about carbon that is sequestered in an area; the carbon is sequestered not just in the plant biomass, but it is also sequestered in the soil, because you have a huge amount of dead and decomposing materials that are there in the soil.

Now, once you expose your soil; so, in that case, the local microclimatic conditions change and this carbon that was stored in the soils that gets released. So, this has an impact on climate change; it has an impact for global warming. It can result in adverse conditions for young crops. What sort of adverse conditions?

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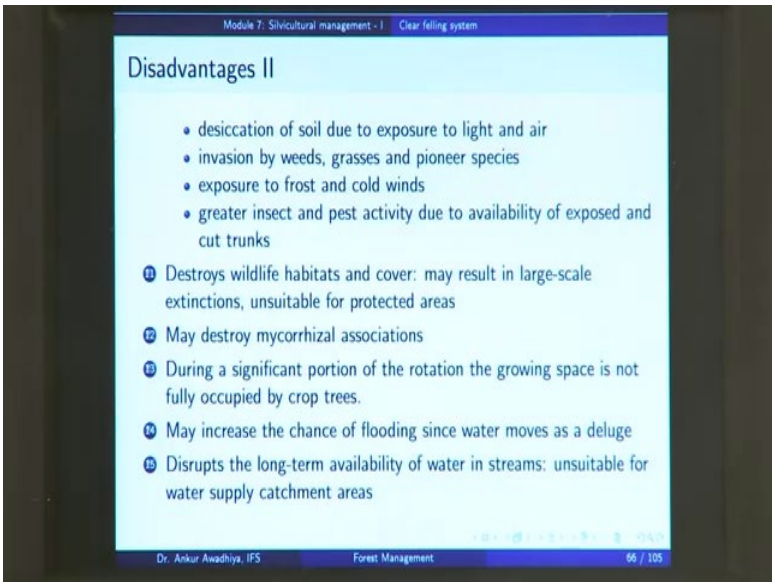

It may lead to desiccation of soil due to exposure to light and air. So, the soil may get dried out, and when you have a soil that is getting dried out, it is not good for the younger generation. It may lead to invasion by weeds, grasses and other pioneer species. Because now there is nothing to outcompete them, and in the case of a number of weeds what we have seen is that, the weeds are extremely light-demanding species.

So, if you have a weed that is the light-demanding species; so, if you have a cover of the previous generation of trees, then the weeds are unable to grow. But once you remove all the trees from the area, then weeds such as Lantana can very easily invade into the area, and then they will cover up the area in no time. And, once they covered this area, it will be very difficult for you to regenerate the species that you wanted to regenerate in this area.

So, there is a very easy invasion by weeds. You can also have invasion by grasses. You can have invasion by pioneer species. Then, your young crops get exposed to frost; into cold winds, which is again not very good for your young crops. There is a greater insect and pest activity due to availability of exposed and cut trunks.

This is also very important, because when you have a tree which is a complete tree, then the insect will have to make a hole in the trunk and then it will be able to reach to the sap. But once you have cut this tree so, the cut portion is exposed. So, in this case, it is very easy for insects and other pests to get their food, and in that situation, the insects will boom their population like anything; and so, the insect and pest attacks on the young crops will be huge. So, this is also another disadvantage of the clear felling system.

Another one is that it destroys wildlife habitats in cover because you do not have any canopy that is left in the area. So, there is a very huge destruction of wildlife habitats, and a very huge destruction of the cover that is that was available for the wildlife. And, this may result in large-scale extinctions, and so, this system is completely unsuitable for protected areas.

Now, in India, in the case of protected areas, we do not do any sort of felling. But even in areas that are to be used also for wildlife purposes, clear felling system is never recommended. Now, it may destroy mycorrhizal associations. Mycorrhizal association refers to the association between fungi and the tree roots, which makes the availability of nutrients very easy for the trees.

Now, once you have exposed the soil by removing all the trees, then this soil will have a very different microclimate. It will be exposed to the sun, and in that case, the fungi may die out, and that would have a very significant consequence on the young crops because, they will not be able to form the mycorrhizal associations. And, in that case, they will not be able to get nutrients as easily as their parent generation was getting.

Now, during a significant portion of the rotation, the growing space is not fully occupied by the crop trees. Now what are we saying here?

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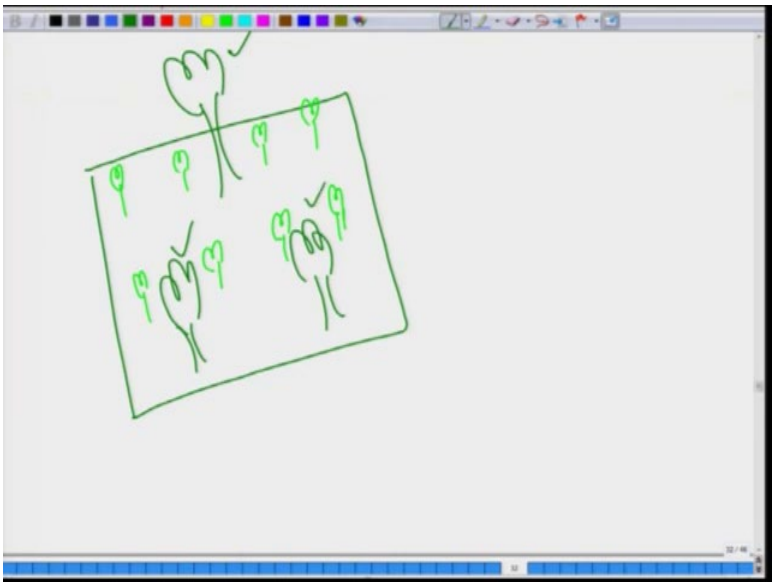

We we are telling that you have this forest. You have removed all the previous generation of trees, and you have these saplings that you have planted. Now, in the early stages, probably this much amount of land could not only support these seedlings; but at the same time, might also have supported say 2 or 3 trees. And, probably you could have left these trees for harvesting at a later point of time.

So, when your seedlings have grown to a certain height, and they now require more amount of nutrients, then you could have cut these trees. So, in that period of time, these 3 trees would have put up more and more increment. But because you remove all the trees in the clear felling system, they are not able to put up this increment.

So, this is an economical loss; this is an ecological loss, and this is a loss for climate change mitigation. So, during a large portion of the rotation, the growing space is not fully occupied by the crop trees, and you could have left a few mother trees. But in this clear felling system, you are not doing that. So, this is a loss. It may also increase the chance of flooding since the water moves as a deluge.

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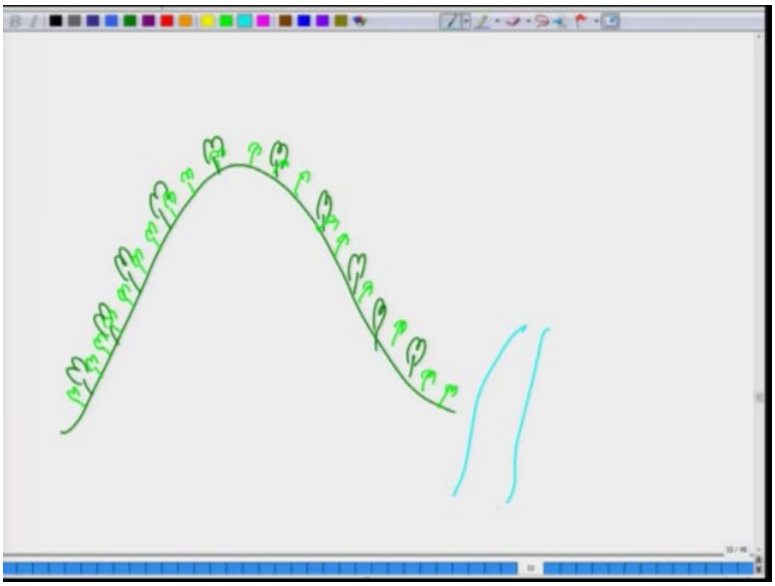

Now, in the case of suppose, we consider this hill and you were having a number of trees here, and under these trees there was you had the forest floor; you had the sub canopy and because of that, any rainfall that came into this area, it was not able to flow down very quickly. Because all of these plants, all of the roots of these plants, they are holding the water back. Now, if you remove all of these trees, what happens is that, you have a small amount of rainfall and all of it comes down in a deluge, in a flood.

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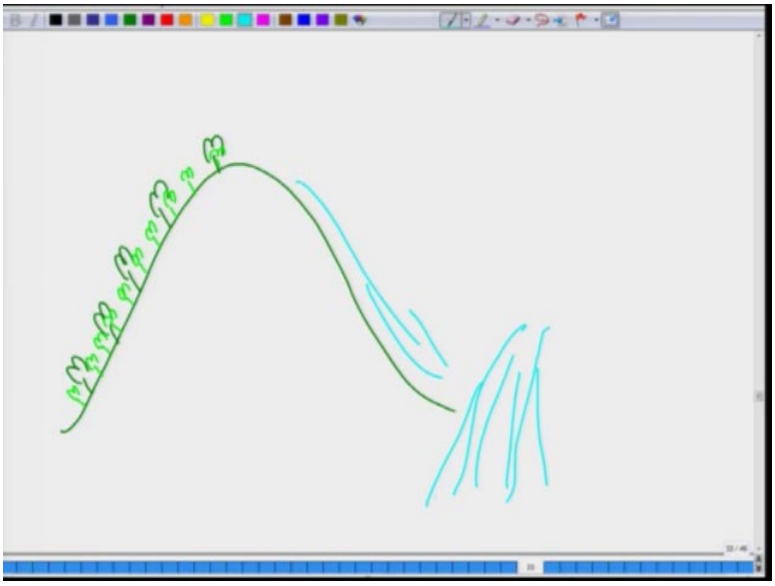

So, there is a possibility that, if you have say a river here and if you have removed these trees, in that case, the water that comes up during the rainy season; will come up in in such a short period of time that this river will now swell and it will flood.

So, there is a chance of flooding. It increases the chances of flooding since the water moves as a deluge; there is nothing to stop the water. Then, it also disrupts the long-term availability of water in the streams and so, it is unsuitable for the water supply catchment areas.

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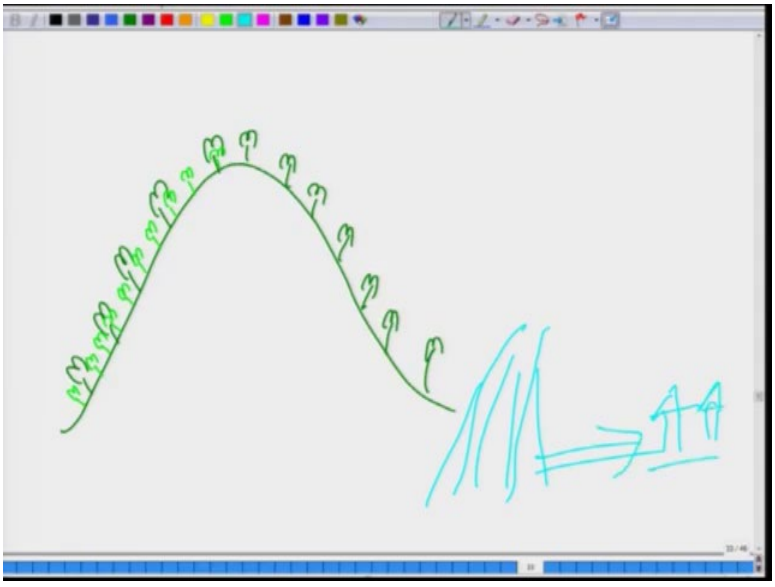

What we are saying here is that, suppose this this hill was providing was a part of the water catchment area - that was supplying water to a nearby town or a nearby village; so, this water was being supplied to the nearby town.

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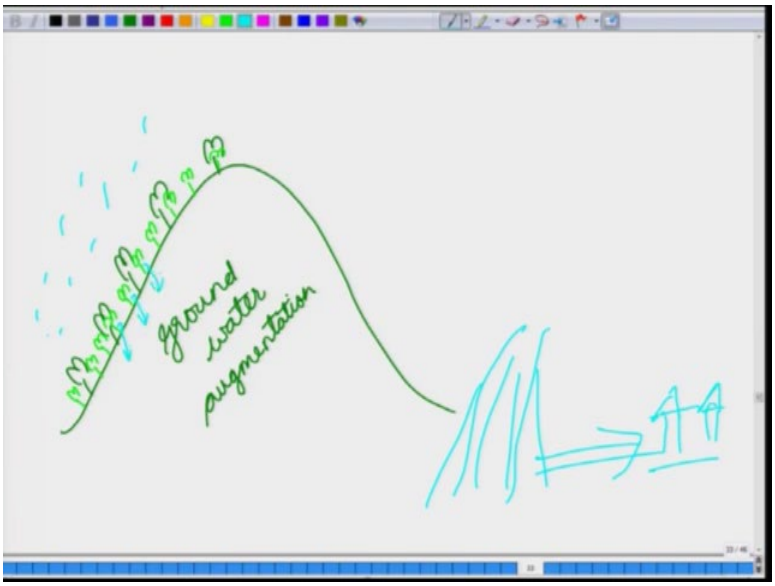

Now, if you remove these trees, then probably the amount of water that will be available for this town it will go down. Now why will it go down? Because during the rainy season, all this water will immediately come down as a deluge; it will get washed away. And, in the rest of the year, earlier what was happening was that this hill was acting as a sponge. It was doing groundwater augmentation because what was happening was that, the rains that were falling here, these trees were stopping the flow of this rain water down and so, this water was getting absorbed into this hill; into the soil. And then, later on, during the seasons that are not seeing the rains, this water was slowly becoming available to the local stream.

And so, you were getting water for a longer period of time. But if you go for a for a clear felling system, so now the groundwater augmentation will reduce and during the rainy season, you will have a flood; and in the other times of the year, you will have a draught.

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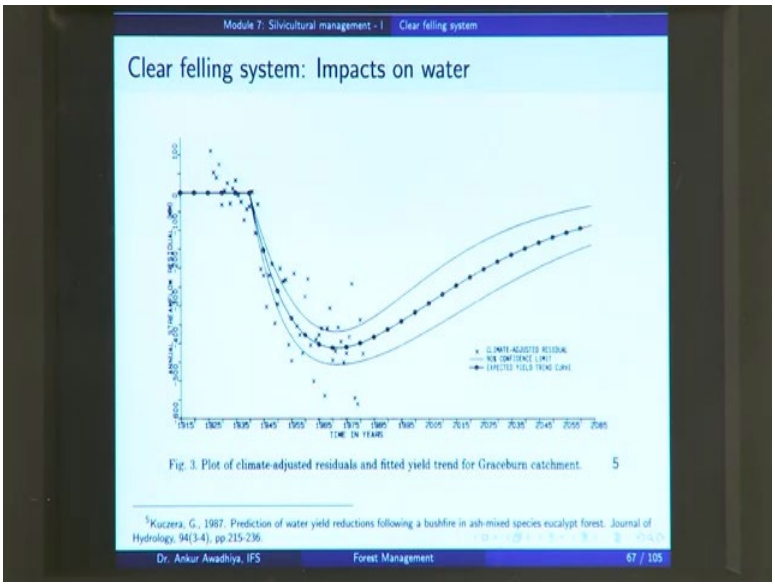

Also, at the same time, we have this curve that is known as the 'Kuczera curve.' Now, this is based on forests readings that were done in Australia. So, this curve on the y-axis, you have the annual stream flow on the y-axis. On the x-axis, you have the year.

Now, what these people were doing was that, they had this forest and they were measuring the amount of water that was made available in the streams. And typically, the what the amount of water that was available in the streams was more or less constant. Then, there was a huge forest fire in this area, and the whole of the area got denuded. Now, remember that when we talk about a clear felling system, we are trying to mimic a forest fire.

So, the results that we can see, in the case of this forest fire, will be the same results that we will find in the case of clear felling system. So, when you have this forest that is now completely denuded, then after a while the young crop will come up. And, when they are - when they are sequestering carbon into their bodies in the form of biomass, they are they are constructing cellulose which is a carbohydrate.

So, they are sequestering carbon, and at the same time, they are sequestering water into their bodies. So, when the streamflow readings were taken, it was found that this level; it dropped sharply after the forest fire, and it has still not reached through to the original level.

So, in the case of a clear felling system, we generally find that there is a loss or a reduction in the amount of stream flow that we will find in the local streams. So, this is also another disadvantage and another consequence of a clear felling system. So, in this lecture, we looked at the clear felling system as a system that is used for our silvicultural operations.

In this system, we typically go and remove all the trees in an area; so, it leads to a very concentrated working; you hardly require any skills. So, it is cheaper; the management is easier, and you get a large amount of profits in a short period of time. The regeneration is typically artificial regeneration; except in some cases where you can have natural regeneration by seed banks, by vegetative propagation, by coupe system.

And, you can use this system either in a departmental fashion, or in a taungya system, in which you take help of the villagers as well. Now, this system is very good, when we talk about a light demanding species, because the canopy is removed; so, all that 100 percent of the light intensity is made available to the young crop.

However, you cannot use it for a shade loving species or a shade tolerant species. This is this system also has some major disadvantages in the form of that, it does not result in a natural looking forest, it makes a forest that is in even-aged forest. And, also it exposes the soil. It and it does not create or it creates conditions that are not very helpful for the young crops. There can be desiccation; there can be exposure to frost; there can be exposure to winds. However, in certain circumstances when you want to control certain diseases, you can go for a for a clear felling system. If you want to change the crop composition of your forest completely, then you can go for a clear felling system.

So, like every system this system also has its own pros and cons. And, these need to be kept in mind, when you have when you are proposing to use the system in your forest. So, that is all for today.

Thank you for your attention, [FL].