Forests and Their Management
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Module - 07
Silvicultural Management – I
Lecture - 19
Regeneration

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[FL]. Today we begin a new module which is Silvicultural Management. This module has 3 lectures; Regeneration, silvicultural systems and clear felling systems.

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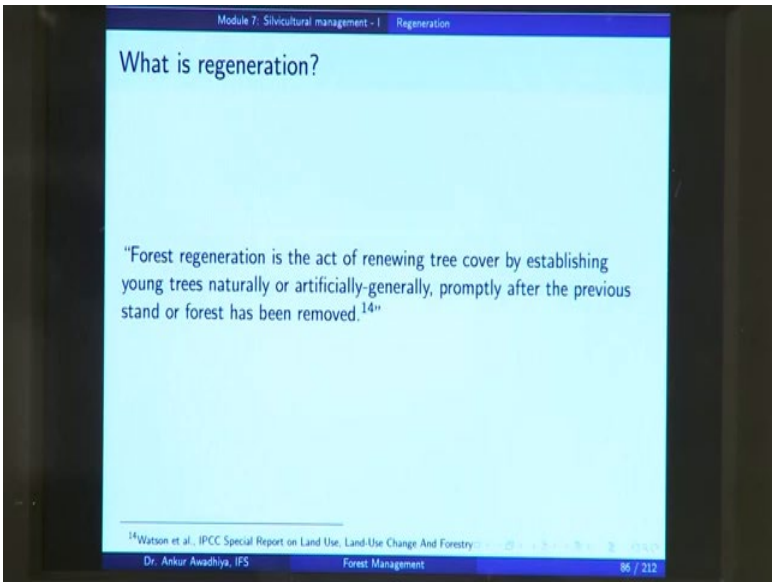

So, we begin with the first lecture – 'Regeneration.'

So, what is regeneration? "Forest regeneration is the act of renewing tree cover by establishing young trees naturally or artificially-generally, promptly after the previous stand or forest has been removed."

So, when we say regeneration; we are generating the forest again. So, why do we need to generate a forest? Because, the previous stand or the forest has been removed. Now, this removal can be because of artificial factors or because of natural factors.

Now, artificial factors could include the harvesting of timber. So, you had a forest you extracted all the timber out of it; for which you had to cut the trees, and once these trees have been cut; now, this site has to be regenerated. So, that the forest will grow again on this particular site.

The second option would be a natural way in which the forest has been degraded. So, for instance, you have a forest and it is subject to forest fires or probably it is subject to an insect infestation; because of which the forest has been lost. So, once this forest has been lost, we now need to regenerate this area. So, that the forest grows again.

So, forest regeneration is the act of renewing the tree cover. So, we are trying to renew the tree cover by establishing young trees, and these young trees can be established either naturally or artificially. So, we will look at both of these natural regeneration and

artificial regeneration, and it is generally done promptly after the previous stand of forest has been removed.

Why is it done promptly after the previous stand has been removed? Because, once the forest cover is removed from an area, the soil becomes exposed. So, the soil is now subject to the desiccating action of sun; it is subject to wind erosion, water erosion, leaking and so on. So, we have to do it as soon as possible before the soil loses its fertility; otherwise if it has lost its fertility, then probably we will have to do more expensive treatments such as the addition of manure or fertilizers. Or in some cases if the soil has been lost because of erosion, will we might have to put the soil back there on the site again.

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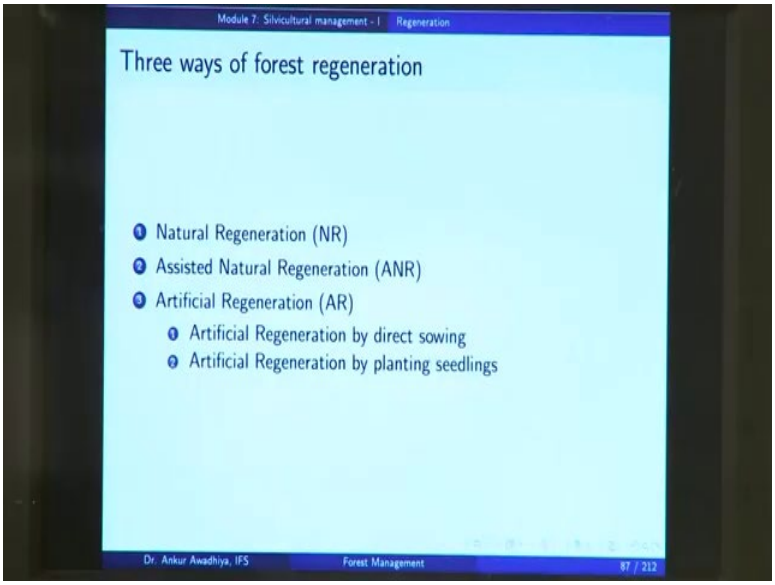

So, there are three ways to regenerate the forest. These are natural regeneration, assisted natural regeneration and artificial regeneration. So, in the case of natural regeneration, you are using the natural processes to regenerate this forest. In the case of assisted national regeneration, you are having a natural regeneration, but you are help that you are giving it some sort of an assistance to help it. And in the case of artificial regeneration, you can do artificial regeneration by direct sowing of seeds or you can do artificial regeneration by planting the seedlings. So, in this case, we are either sowing seeds or we are planting new plants.

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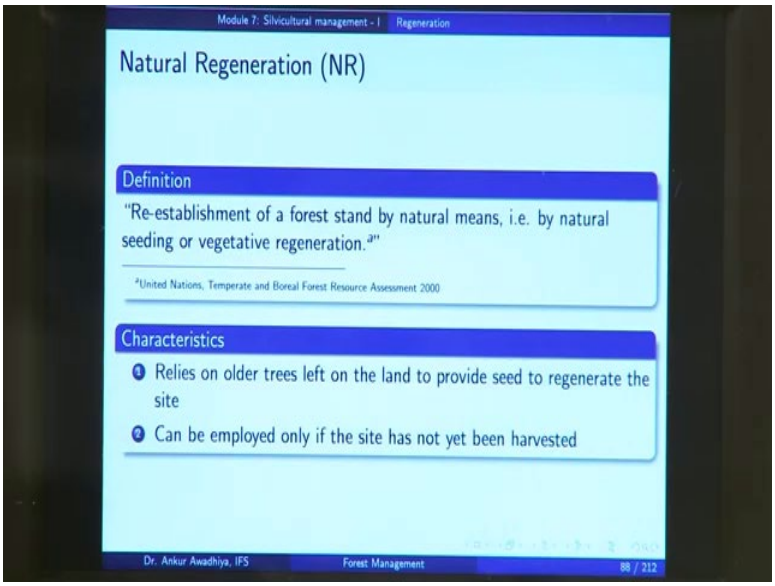

So, let us now have a look at natural regeneration. Natural regeneration is defined as re-establishment of a forest stand by natural means that is by natural seeding or vegetative regeneration. So, we are re-establishing the forest stand by natural means, and there are two natural means; one is natural seeding. So, a number of trees produce their the fruits which have the seeds, and these seeds when they are released into the environment; they germinate and form the new seedlings, or the other option is vegetative regeneration.

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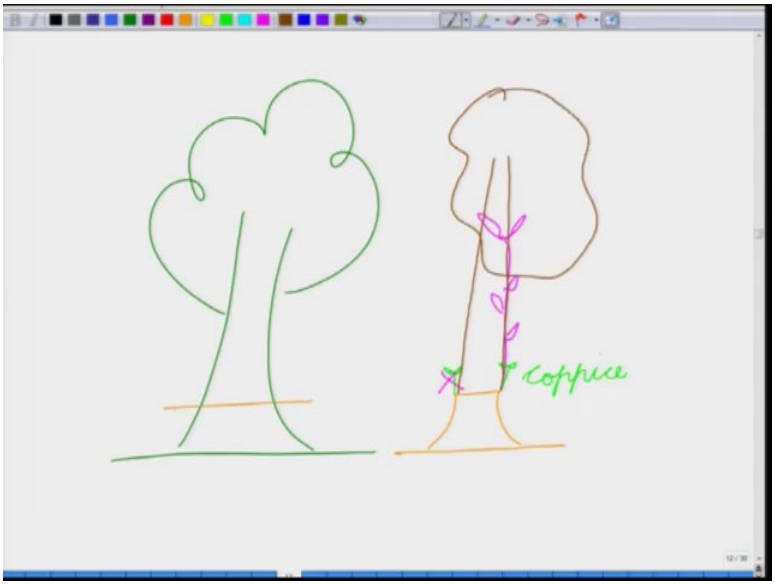

So, a good example of vegetative regeneration is coppicing. Now, what happens in coppicing is that you have this tree, and then for harvesting of timber this tree, is cut at this location. So, now, what you are left with is a stump; but then, with the next rains this stump will start giving out shoots here and these shoots will be known as coppices. c o double p i c e, and with time these coppices; so, what we generally do is; we remove one of these coppices and allow one to grow. So, then this coppice will after a while. it will form the seedling; it will form the new tree.

So, after a while what you will see is that this portion has now formed into a new tree. So, this is a vegetative regeneration of the forest by natural means. So, it comes under natural regeneration. So, the characteristics are that it relies on older trees left on the land to provide seed to regenerate the site. So, in this case, we are leaving out the older trees. This seed - these trees are also known as seed trees or mother trees. So, we leave them out on the land so that they produce the seeds, and these seeds then regenerate the forest. And, the second characteristic is that it can be employed, only if the site has not yet been harvested. So, suppose you have a forest and you have completely harvested your forest. So, that no tree remains on the site. In that case, you cannot go for natural regeneration because there is no possibility of new seed production in the area.

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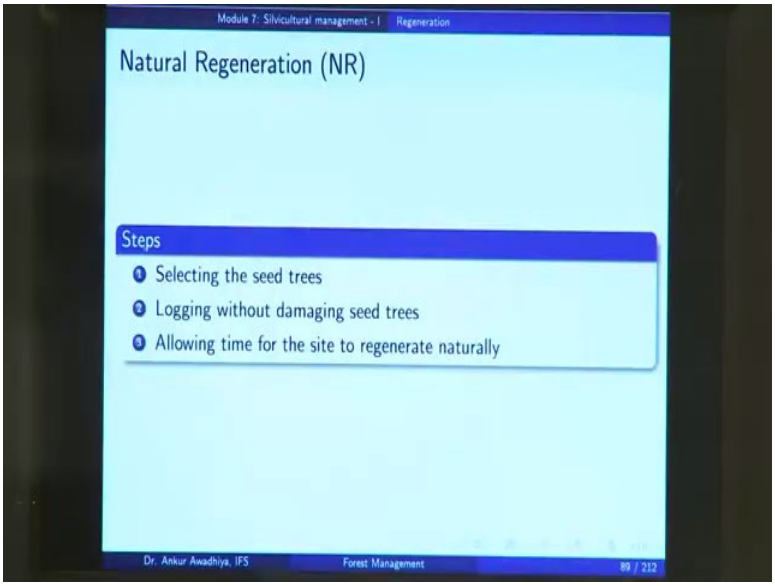

So, the steps are one; you select the seed trees. Now, the seed trees have to be selected because they should be of a desirable characteristic. So, if you have those plants that are

very young or very old, they might not produce copious amounts of seeds, whereas the matured plants that are in the prime of their health will produce a larger number of seeds.

So, when you are harvesting your forest, the first consideration is that you should leave out the seed trees; they should not be harvested. So, you select the seed trees, then you log the area without damaging the seed trees, and then you allow time for the site to regenerate naturally.

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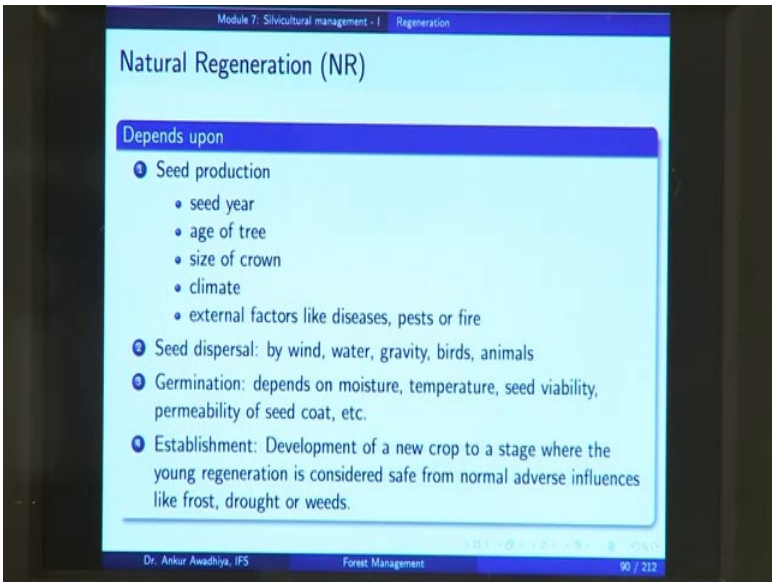

Now, naturally regeneration is dependent on a number of factors that are mostly out of our control. So, it depends on seed production. So, suppose you went for a natural regeneration and you created a site; you left out the seed trees, but then in that particular year, these trees did not produce a number of seeds; or probably, they did not produce viable seeds, which means that the seeds were formed, but those seeds were not capable of germinating.

So, what will happen in that case is that, because you do not have any control, your forests will not regenerate. So, it depends on a lot on the seed production in that year, which depends on seed year, age of the tree, size of the crown, climate external factors. Now what is seed year? Generally, for a number of species, we observe that the number of seeds that are produced in every year will vary. And generally, in every 3 or 4 years, there will be 1 year in which these trees will produce a very large number of seeds. So,

that year in which a tree produces a very large number of seeds; a very large number of viable seeds, is known as a seed year

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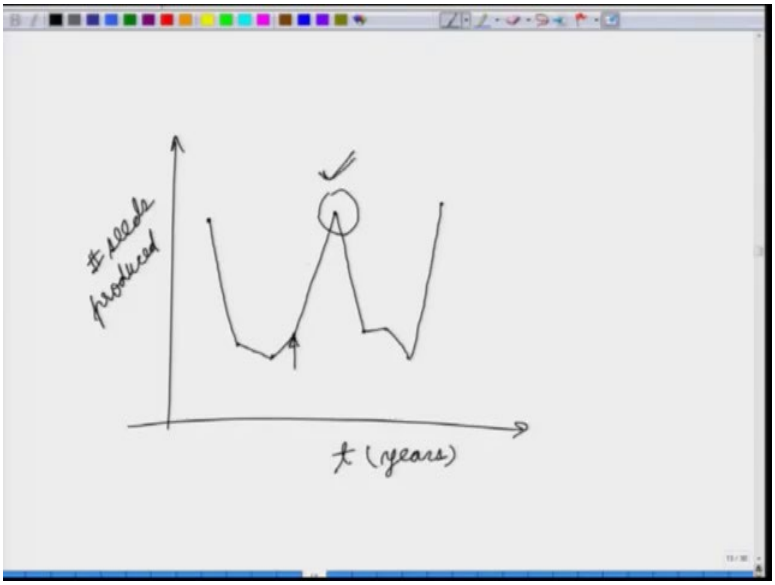

So, what we do in this case is that, if you have a species that shows this characteristic; so, what you will see is that, the number of seeds produced versus time in years. So, there will be a year in which the seed production is very high; next year it will be low, then it is again low; then again low; and then this year, its high; then its low for 3 years, and then again, its high. So, if your species shows this characteristic, and that is what you should do is that you should time your logging or harvesting of your forest, in such a manner that when you want seeds to be produce, it comes in the seed year.

So, essentially what you will do is that you log after this point because the next year you will have a large number of seeds. So, natural regeneration is dependent on seed production, which depends on the seed year. It also depends on the age of the tree. So, if your tree is a matured tree; not very young, not very old, in the prime of its health, then it will produce a large number of seeds. It also depends on the size of the crown. So, what do we mean by size of the crown?

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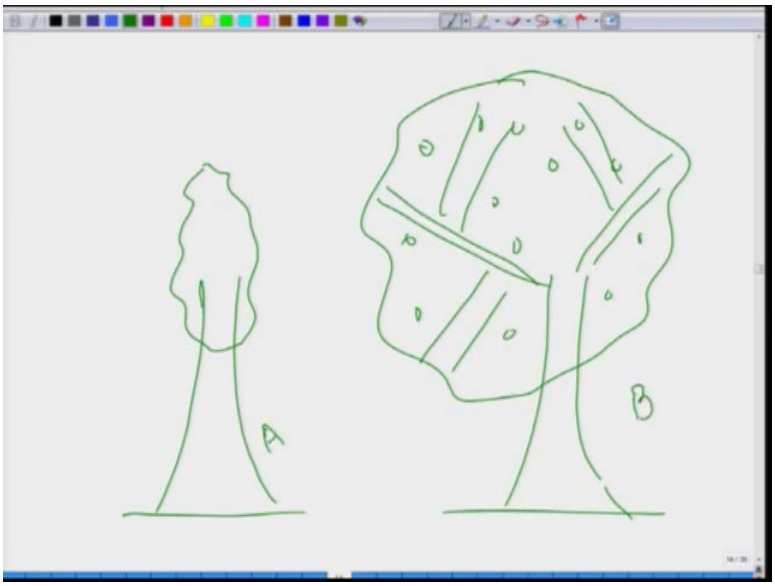

Suppose, we have 2 trees, both are of the same size, but this tree has as a small crown, but this tree has a very large sized crown. So, by a very large size crown, we mean that it will be having a number of branches and a large number of leaves in this tree.

So, what happens is that because this tree, this tree B is having; so, this is A, this is B. So, because tree B is having a large crown size; large number of branches. So, those branches are the locations where it will have the fruits; it will have the flowers, and then it will have the fruits, which will have the seeds. So, more number of branches would generally mean that it will be having more number of fruits. Also, more number of leaves means that it has a very high amount of photosynthesis, which means that it is able to capture more and more energy; it is able to divert all the those energy for seed production.

So, if you have a larger crowns tree, then it will produce more number of seeds. It also depends on the climate. So, if there is a mismatch of the of the climate; if there is an extreme climate or an extreme weather, then the then the seed production will be affected. It also depends on external factors like diseases pests or fire.

So, if you have a tree that is a diseased tree, or if it has pests such as insects; so, there are a number of insects that are living on that tree with that have made holes in that in the trunk of that tree, and which are draining out the resources from that tree. So, the amount of energy that the that this tree will be able to devote to seed production will be less. So,

typically, a tree that is diseased or is extremely pest infested will be having less number of seeds. It also depends on fire. So, in the case of, if you have a forest that has recently been exposed to a forest fire, then typically your trees will not be in a very good condition to produce the seeds.

Now, natural regeneration also depends on seed dispersal by wind, water, gravity, birds and animals. So, what it means is that if you have a tree.

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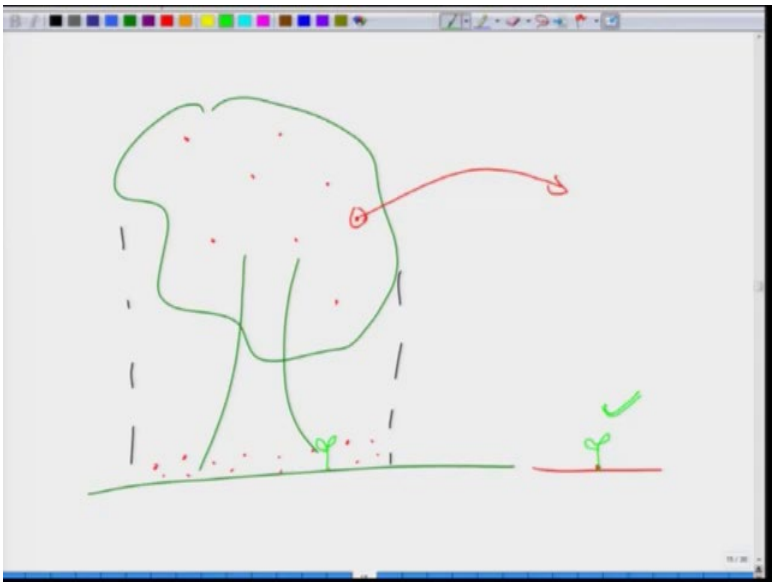

So, here is your tree and when this tree produces the seeds, they fall on the ground here. Now, if your seeds fall here and when a plant grows; when the next generation grows, this next generation is coming in the shade area of the mother tree. So, in which case, your seedling will not be able to get enough amount of sunlight; because of which, it might not grow as well.

Whereas if you have a condition in which when you have these seeds; or when you have these fruits and then there is a bird that eats up these seeds, and then goes to another location, and then with its dropping the seed falls here. So, it is now away from the shade zone of its mother tree.

So, what happens in that case is that, when the seedling grows, it gets enough amount of light and it is able to show a very good amount of growth. So, natural regeneration will

also depend on seed dispersal. So, if you have seed dispersal by these different means, in that case, the quantum of natural regeneration will be much better.

Now, your seed where ours your seeds were produced, then they got dispersed. The next stage is germination. So, germination is the stage, in which your seed gives out a new seedling. Germination is dependent on moisture, temperature, seed viability, permeability of seed coat, and other factors.

So, if you have a seed and your seed fell into an area that was very dry.

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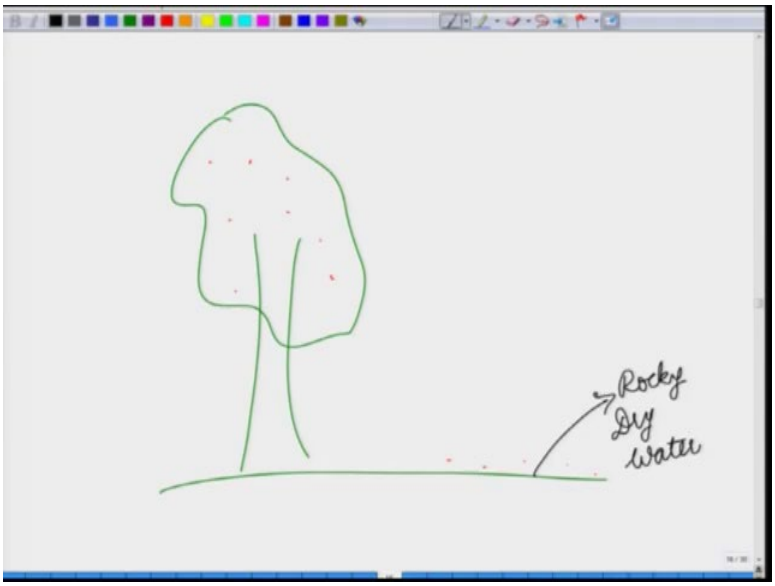

So, here you have seeds. Now, your seeds got dispersed, but they got dispersed into an area that was say a rocky area, or an extremely dry area, or probably they got dispersed to an area that is waterlogged. So, in these conditions, your seeds might not be able to germinate. Now, if your seed does not germinate, then your regeneration will not happen. So, this is also a factor that controls the natural regeneration.

Next is establishment. Establishment is development of a new crop to a stage where the young regeneration safe for normal from normal adverse influences like frost draught or weeds. So, what is establishment? In this case, suppose your seeds fell into an area that was in area, but then birds came and ate of these seeds. So, these seeds get eaten up. What will happen then?

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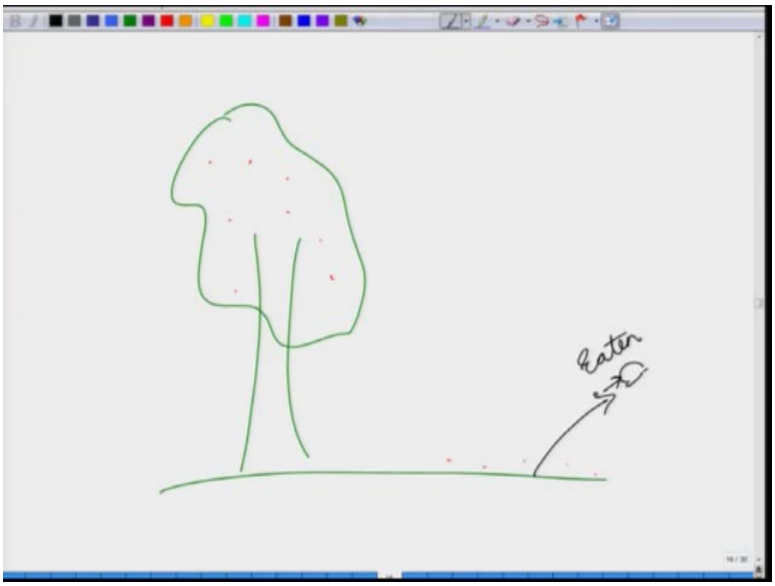

Your seeds, even though they were capable of germinating, probably a few of those seeds have already germinated; but then they got eaten up. Now, will have to protect these young seeds and seedlings to a stage when where they are where they are able to resist the adverse influences.

So, the time at which your new crop has reached to a level of maturity that it is safe from normal adverse influences. Now, the point through highlight here is normal adverse influences. When we talk about establishment, we are not talking about all the adverse influences. So, even after your new crop has established, and if there is say a forest fire, it is possible that your regeneration is gone.

But then, in the case of establishment, we are only saying the normal adverse circumstances like frost, draught or weeds. So, if your seed is able; so, if your stand is able to reach this stage; your young crop are able to reach this stage, then your natural regeneration will be ok.

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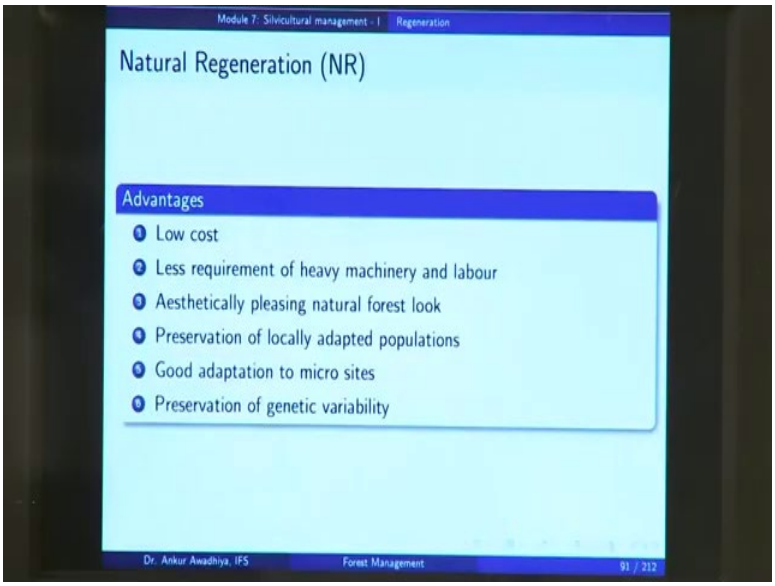

Now, natural regeneration has a number of advantages. The most important being low cost; it is practically free. So, you when you are doing your logging, you just leave a few trees and mother nature will take care of the other things; so, it is low cost. There is a less requirement of heavy machinery and labour. Practically, you do not have to do anything; the natural forces of dispersal will take care of everything. So, you do not have a large requirement of heavy machinery or labour.

It gives you an aesthetically pleasing natural forest look. Because, this is a natural process. So, all the forest will look like a natural forest when they form it helps in preservation of adapted populations. What does that mean?

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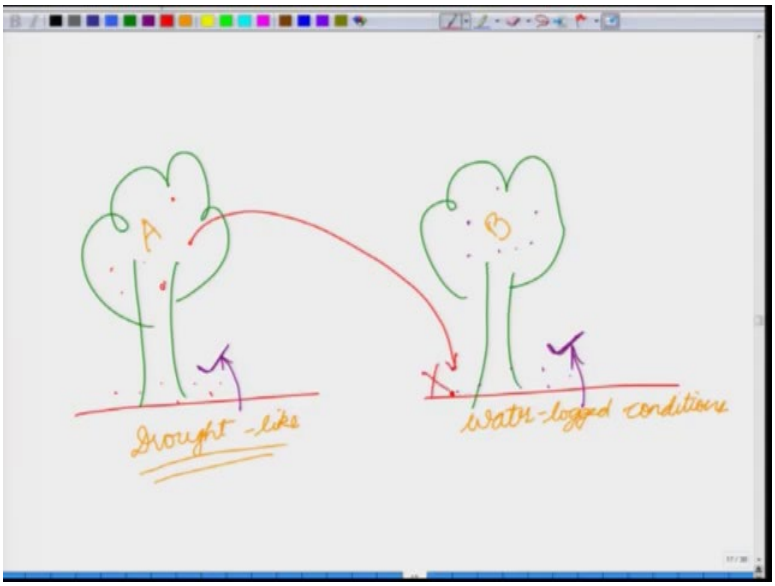

Suppose, you have a site; suppose you have 2 sites. Now, both these sites you have trees of the same species, but probably this site has more draught like conditions and this site has a more waterlogged lake conditions.

Now, in this case, when your when your tree A was, when this site was being populated by new trees, because you had a draught like situation. So, those individuals that were better able to tolerate draught or were better able to resist the draught form in this location A. Whereas, those individuals that are better able to resist waterlogged conditions are get established in the location B.

Now, in the case of natural regeneration, what happens is that the next generation of progeny that forms in this area also has the abilities to tolerate draught, and the next generation that forms in this area also has abilities through genetics to be better able to resist the waterlogged situations. And, this is a very big advantage of natural regeneration, because, in things like artificial regeneration when we are planting the seeds, it is very difficult to ensure that all the local micro-climatic conditions are matched accurately.

So, for instance, if you went for an artificial regeneration and you took these seeds from A and if you planted them here in the B's side, then because these seeds; the red seeds are able to tolerate draught, but they are unable to tolerate the water logged situations. So, your regeneration would not have occurred. But in the case of natural regeneration,

the preservation of locally adapted populations ensures that the that the level of survival is better. So, there is also a good adaptation to micro sites and there is also a preservation of genetic variability.

Why a preservation of genetic variability? Because, in the case of artificial regeneration, because you are you are collecting seeds from a few trees. So, it is not possible to collect from a very large number of trees. So, in that case, those trees that you collected the seeds from their genetic constitution is ah is maintained in the next generation, whereas the other genetic variability; that was there in the site, gets lost. Whereas, in the case of natural regeneration, because you do not have to do anything; you just have to leave a few trees. So, typically a larger number of trees are left and so, the genetic variability that is present in the site is preserved.

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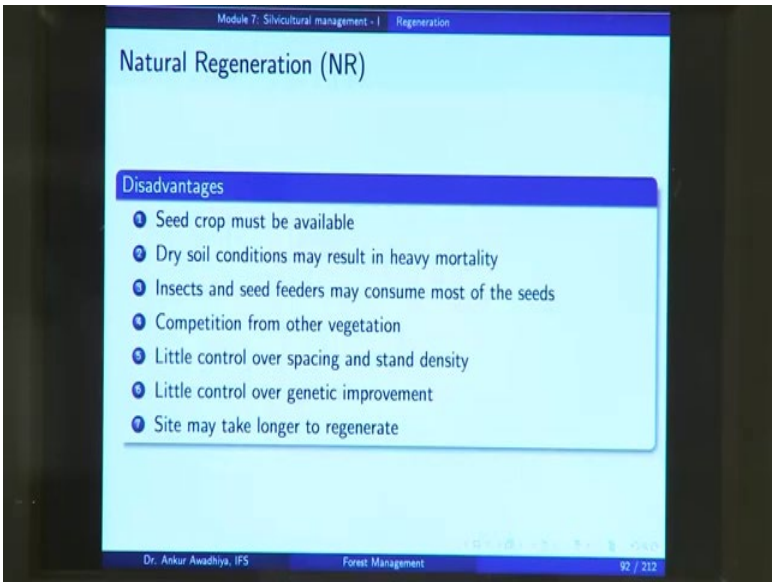

However natural regeneration also has certain disadvantages. One; the seed crop must be available. For instance, if you want to regenerate an area that does not have any seed trees left, then you cannot go for natural regeneration. Dry soil conditions may result in heavy mortality.

Now, in the case of natural regeneration, what you are doing is that you are removing a large number of trees for timber and you are leaving out a few trees as mother trees. But then because, you have removed the other trees; so, sunlight is able to reach to the soil surface and its also able to desiccate the soil. Theis dry soil conditions may result in

heavy mortality; could be heavy mortality, because of insects and seed feeders that consume a number of seeds.

So, because of these factors - the dry soil and the insect conditions, you do not have much control over the success rate of natural regeneration, and there have also been conditions or cases, where the foresters went for a natural regeneration, but were unable to regenerate the site.

So, in that case of a beautiful looking hill, that was come that was all full of trees; you went for a natural regeneration. But then, in that year, you were unable to regenerate it naturally. So, now, that complete hill has become denuded.

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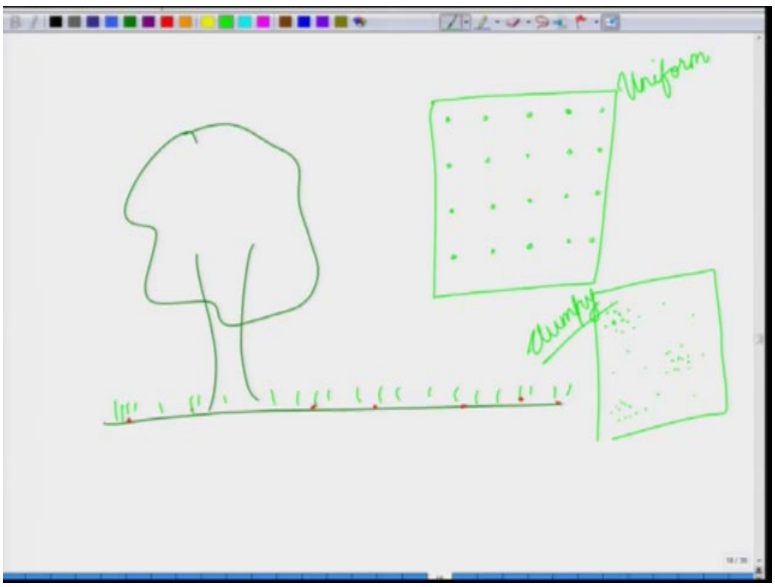

So, we also have examples such as the these. Then there is competition from other vegetation. Because, what is happening in this natural regeneration is that, you left out this mother tree, it gave out the seeds that got dispersed; but then, there is grass on the forest floor or probably there are some shrubs or probably there are some other trees that are now competing with your seedlings. So, because of this competition, there is a good chance that your regeneration might fail even more; so, because you are not doing anything to help your regeneration.

Then, there is little control over spacing and stand density. So, if you want to manage a stand for timber; you will probably want to go for a situation, in which your spacing is

well controlled. So, for instance, you will want to go for an area in which you plant seeds like these. So, that all your plants are at the same distance and are better able to utilize the resources. And, it also makes it easy to perform any management operations later on.

But in the case of a natural regeneration, because you do not have any control over where your seeds are falling; you will have a situation in which in certain locations, you will have a more clumpy formation of your stand. In other locations, you will you might have areas with very sparse number of trees.

So, if you go for a with a natural regeneration, then you do not have a good control over the spacing in your stand and so, it might make it difficult to later on to perform other management operations. Also, you have a very less control over the stand density. So, here your density was uniform, if you went for artificial regeneration; but here you have a clumpy regeneration and so, there is a very less control over the density in your stand. There is also little control over genetic improvement. Because, you are not selecting those trees that and that have those properties that are better suited to your operations.

So, for instance, in if you want to manage a stand for timber, you will probably want trees that grow very fast that attain a very good height; that have a very smooth bowl; and, that do not have a large number of branches; because the more the number of branches, the more wood is there that gets lost during the operations.

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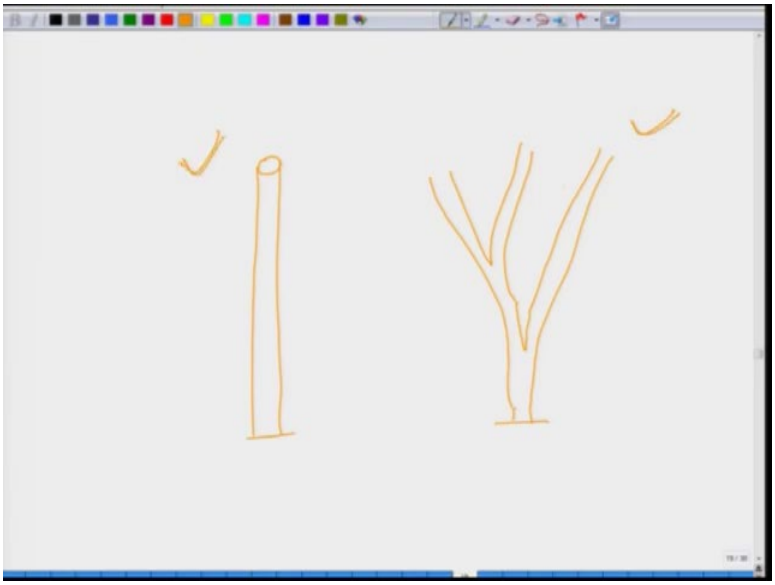

So, you will select for those trees that have a cylindrical bowl like this. Whereas, in the case of natural regeneration, you might have a situation in which the trees have a very irregular bowl with a large number of branches.

So, even though you want trees like this, but you get trees like this. So, you do not have much control over genetic improvement. You cannot select those trees that have your desired qualities and the site may also take longer to regenerate, because there is nothing in your control. So, it might take longer to regenerate.

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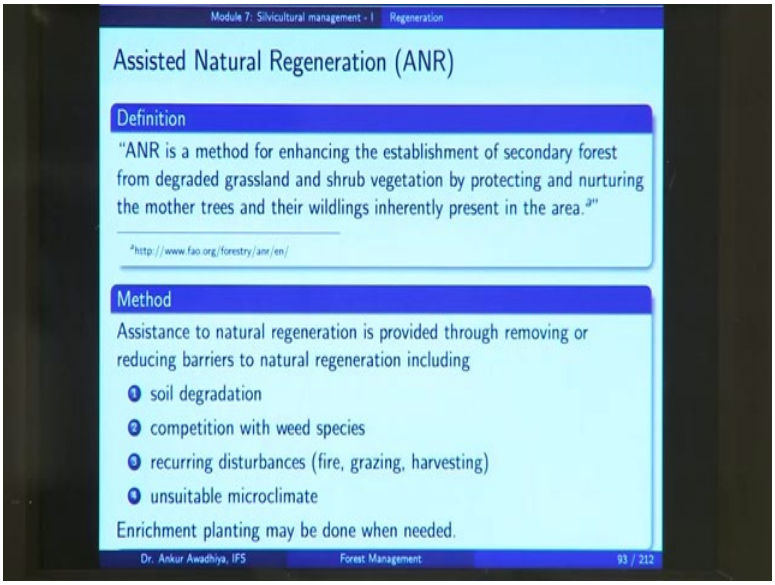

So, to overcome these disadvantages, we have got two options. We can go for assisted natural regeneration or we can go for artificial regeneration.

Now, Assisted Natural Regeneration is or ANR is a method for enhancing the establishment of secondary forest from degraded grassland and shrub vegetation, by protecting and nurturing the mother trees and their wildings inherently present in the area.

So, what you are doing here is that you are assisting or helping the natural regeneration. So, that the establishment of the secondary forest gets enhanced. And how are you doing it? You are doing it by protecting and nurturing both the mother trees and the wildings or the progeny.

So, how do you do that? The method is that you give assistance to natural regeneration through removing or reducing the barriers to natural regeneration. So, we are trying to reduce the barriers, and these barriers include soil degradation, competition with weed species, recurring disturbances, unsuitable microclimate and so on. And, enrichment planting may also be done as in when required.

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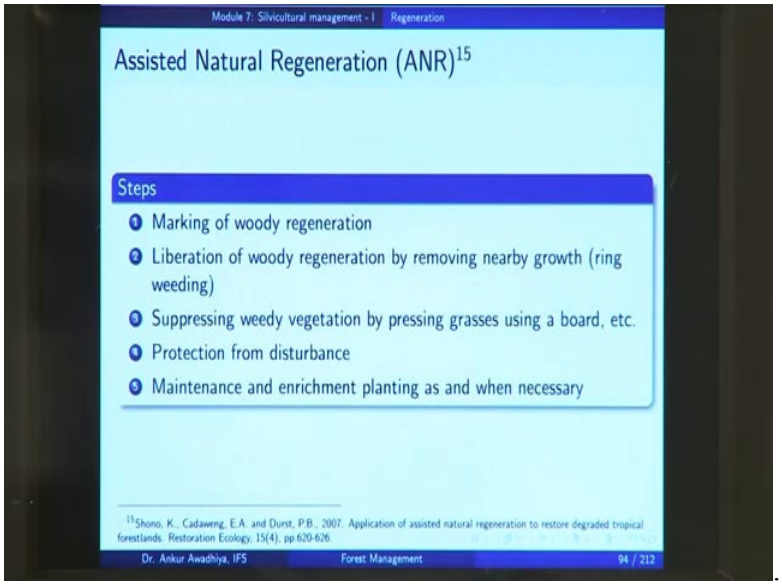

So, what are the steps in ANR?

The first thing is that, you do a marking of the woody regeneration and then, you liberate the woody regeneration by removing the nearby growth also through our process called ring weeding.

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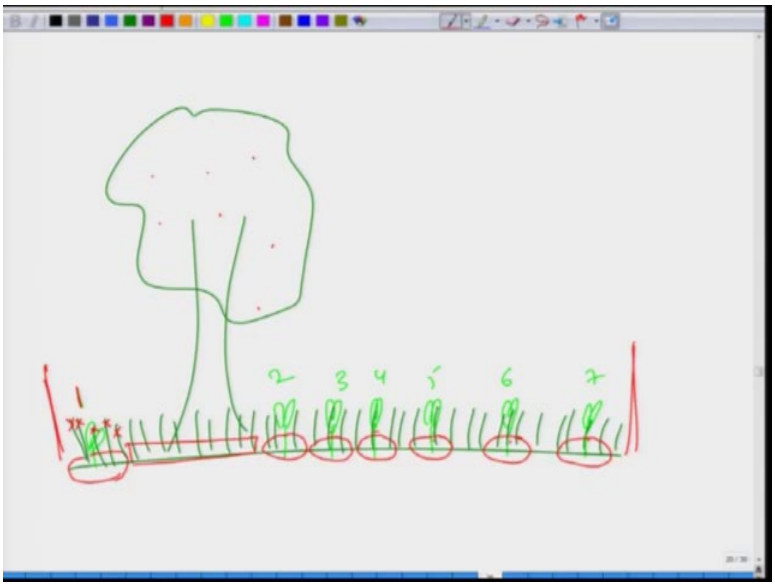

So, what you are doing here is that you had this mother tree that produce these seeds, and these seeds are now there on the ground. And, they have given out the seedlings at these locations.

So, what you do here is the first step is that, you mark this woody regeneration, which means that you note that you have these woody regeneration 1, 2, 3, 4, 5, 6, 7. So, you note that you have woody regeneration here. Next, you liberate this woody regeneration by removing the nearby growth in a ring weeding fashion.

What does that mean? It means that; suppose you had grasses in this whole area; so, in the case of ring weeding, what you will do is, for every individual that you have bark, you create a ring around it and you remove all the grasses that are there in this region; in this ring. So, you are not trying to remove all the grasses, but around every plant in a ring fashion; you are removing the grasses; so, that the competition that your seedling was facing is now removed.

So, you liberate; this is known as liberation. So, you liberate the woody regeneration by removing the nearby growth in a ring weeding fashion. Then, you can also go for suppressing the weedy vegetation by pressing grass using a board etcetera. So, in this case you did a ring weeding, but you also try to suppress the nearby grass, by putting a board here and pressing all of these grasses. So, that you try to crush these grasses.

Next, you protect this area from disturbance. So, another assistance that you give to this regeneration is that you have suppressed these grasses; but then, you create a fencing or a social fencing and you will say that this area is now out of bounds; you cannot take your cattle inside this area, because we have these seedlings that have to be protected; which have to be assisted. So, you try to remove or reduce all sorts of disturbances. So, you try to reduce or you try to prohibit cattle grazing in that area. You give it a very good amount of protection against forest fires; you try to give protection against even diseases.

So, how can you protect this area against diseases? Is there a if there is any disease tree, you try to cut it down and you burn it. So that, your incidence of disease in this area also goes down. So, all these are the kinds of assistance that you give to your regeneration. And then maintenance and enrichment planting as and when necessary, which means that, if after doing all of this suppose, you have certain patches in which your regeneration is still poor. So, in that case, you will go for a maintenance or an enrichment planting. So, you will go and you will plant seeds; or, you are you will plant the seedlings yourself. So, this is assisted natural regeneration.

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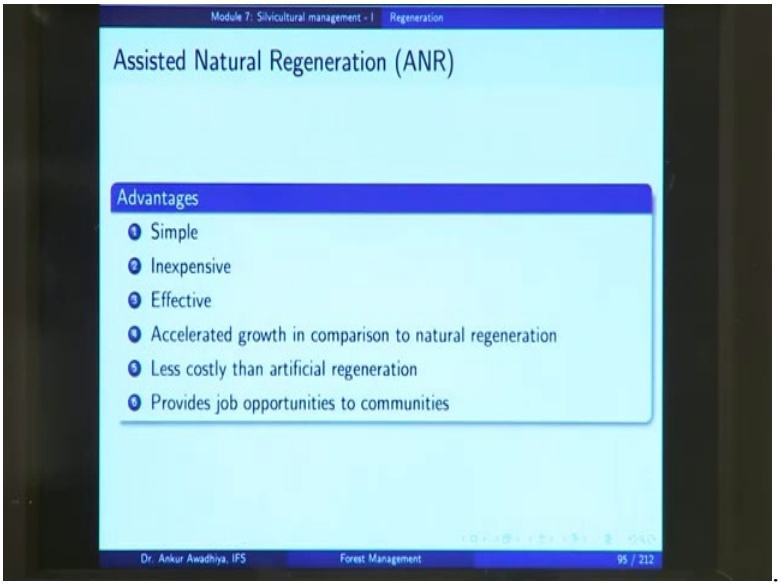

Advantages - It is simple; it is much simpler than artificial regeneration. It is inexpensive; it is a bit more expensive than natural regeneration, but still it is very inexpensive as compared to artificial regeneration. It is very effective. There is accelerated growth in comparison to national regeneration. It is less costly than artificial

regeneration and it also provides job opportunities to communities. Because, who will do this marking of your woody regeneration, who will do the ring weeding, who will do separation of your grasses using a board? So, you take help of the local communities, which also provides them with job opportunities. So, these are the advantages of assisted natural regeneration.

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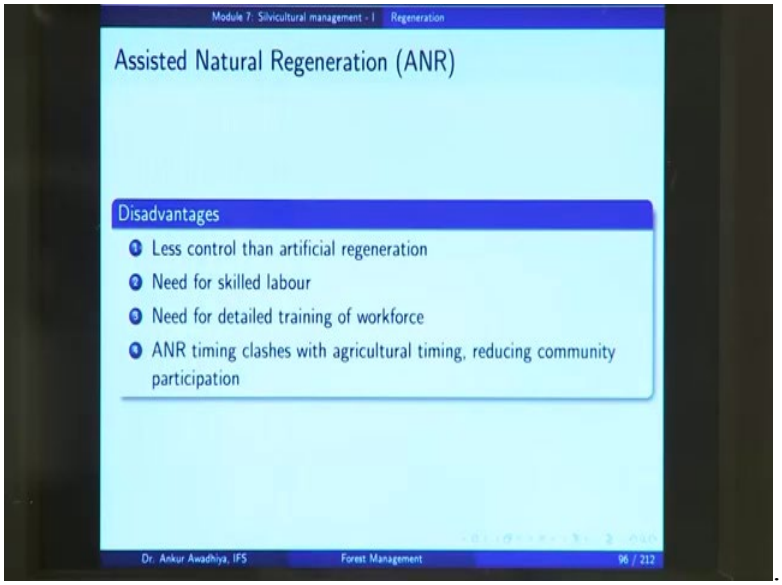

Then, let us have a look at the disadvantages. There is less control than artificial regeneration. So, the highest level of control is with artificial regeneration; here, your level of control is lesser. There is a need for skilled labour, because you need to train your labour on how to identify your woody regeneration; how to perform the ring reading; how to use a board to suppress the grass; how to protect this area against fire; how to protect this area against cattle; how to perform fencing; so, for all of these things you need to provide certain skills to the labour.

Then, there is a need for detailed training of the workforce. So, you need skilled labour; you provide them with training and also, another disadvantage is that the ANR timing, it often clashes with the agricultural timing, which reduces community participation. What it means here is that. when you are trying to do, when you are trying to perform ANR, what happens in this case is that, the timing for your seedling growth is the same as that of the agricultural season.

So, even though on one hand we try to provide job opportunities to the communities, but then those people are also required in the agricultural operations. So, at times it happens that people go for agriculture; they do not come for these ANR operations, in which case we are not able to do the ANR.

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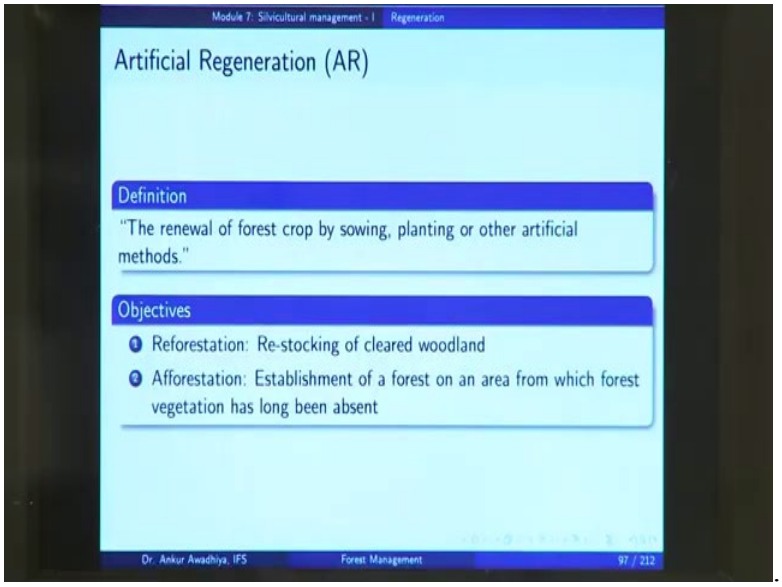

The third kind of regeneration is an Artificial Regeneration or AR. It is the renewal of forest crop by sowing planting or other artificial methods. So, you are trying to renew the forest by direct sowing of the seeds, by planting your saplings, or by other artificial methods.

The objectives here can be reforestation or afforestation. Now, reforestation is re-stocking of the cleared woodland. And, afforestation is establishment of a forest on an area from which forest vegetation has long been absent. Now, artificial regeneration is something that you can use even on those areas that do not have any existing vegetation.

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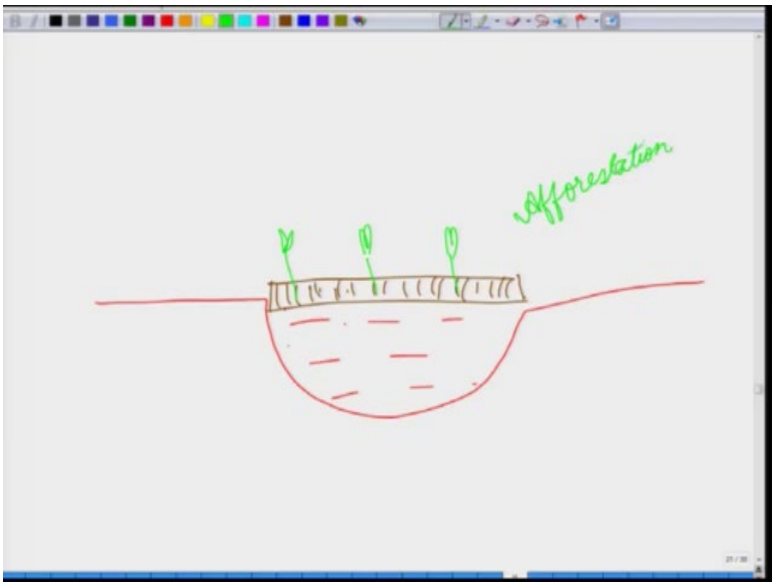

So, for instance, you had an area where a mining operation was done. So, now, this area is safe; full of water or it is full of your toxic minerals. So, what you can do here is - you can put soil on top of it; so, you add a layer of soil. Now, on this layer of soil, you want to grow the trees. Now, we cannot go for natural regeneration or assisted natural regeneration in this area, because we do not have any mother trees in this area. But in the case of artificial regeneration; because, we are planting saplings in into this area, we can bring these saplings from other areas, and so, your artificial regeneration can be used in such areas as well.

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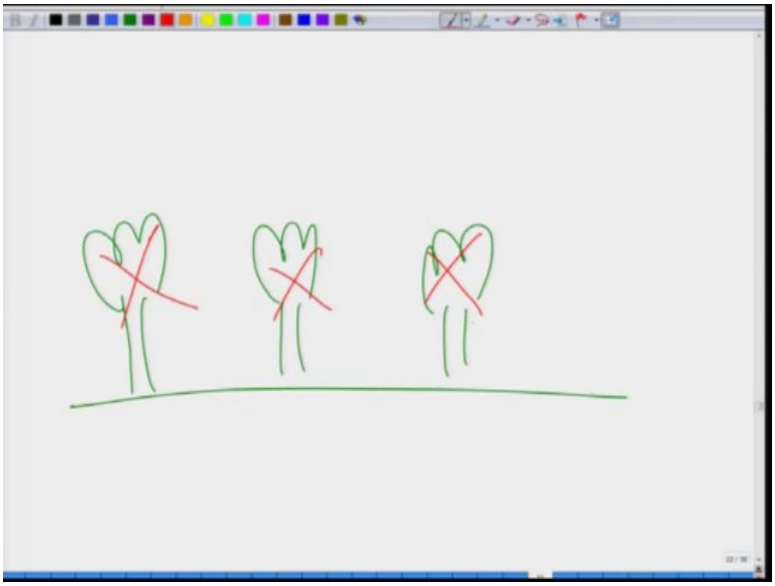

So, when we do something like this, this is known as afforestation. Whereas, in another situation where we had a forest and we cut these trees for or we harvested these trees for timber and so now, we have a plain area and then, we put saplings in this area; this process will be known as reforestation.

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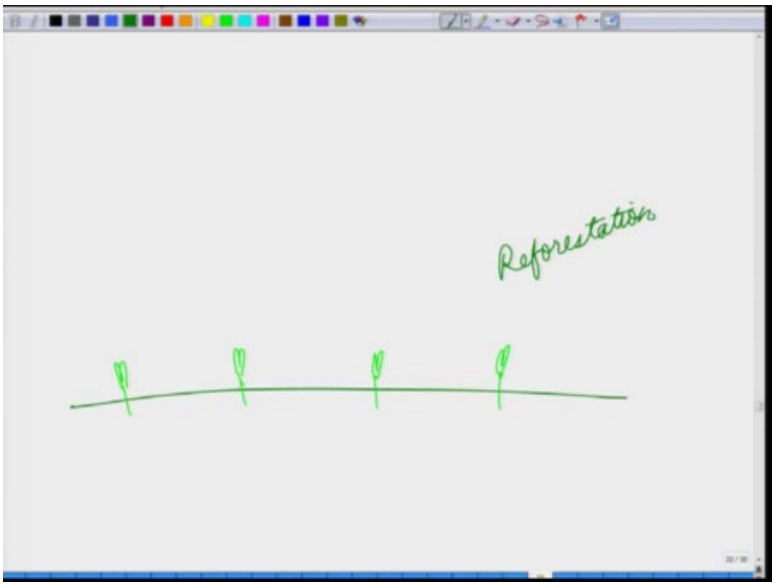

So, in reforestation, we are putting the forest back again. In the case of afforestation, we are creating a new forest. So, that is the difference between afforestation and reforestation. Now, for reforestation, you can go with natural regeneration, assisted natural regeneration or artificial regeneration. But in the case of afforestation, you can only go with artificial regeneration.

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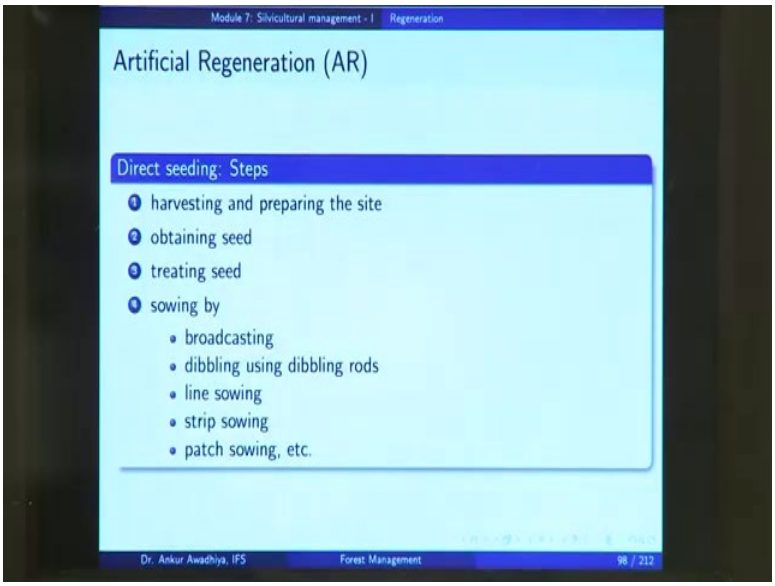

So, artificial regeneration can be done by direct seeding, in which case, you are putting the seeds in this area. So, what are the steps? One you harvest the area and prepare the site. So, harvesting the area is cutting out the earlier generation of trees. So, you have harvested them out for timber and then you prepare the area.

What do we mean by preparing the area? If you put seeds on a hard ground probably, they will not be able to germinate or establish themselves. So, in this case, you can go for things like ploughing. So, you can till the soil; you can plough the soil. So, that it becomes a bit more pervious and your seeds are able to reach inside easily. So, you prepare the site. You might even have to add some nutrients in the form of fertilizers or manures. So, that is harvesting and preparing the site; after that you go for obtaining the seed. So, you have to collect the seed from other trees, then you treat the seeds.

Now, this seed treatment can be to make the to crack open the seed coat, so that germination becomes easier, or it may even be to reduce the chances of infestation or diseases. So, in that case, you take your seeds you treat them with a fungicide or with an insecticide, so that the insects and the fungi get killed, and then you use those seeds. So, that is treating the seeds.

Then, you perform sowing. Now, this sowing can be through broadcasting. Now, what is broadcasting? In the case of broadcasting, you just take your seeds and you spread them

out; you just throw them into the area, and when you throw those seeds, they get dispersed, and that is sowing by broadcasting.

Next, you have sowing by dibbling using dibbling rods. Now, what is dibbling? Dibbling is a process in which you have a rod that is pointed at one end, and then you make a hole with this rod and then you put a seed inside. So, when you are doing this, the advantage over broadcasting is that your seed is inside the soil, and it is much more protected from from animals like birds or insects, because it is now inside. So, you can go for dibbling.

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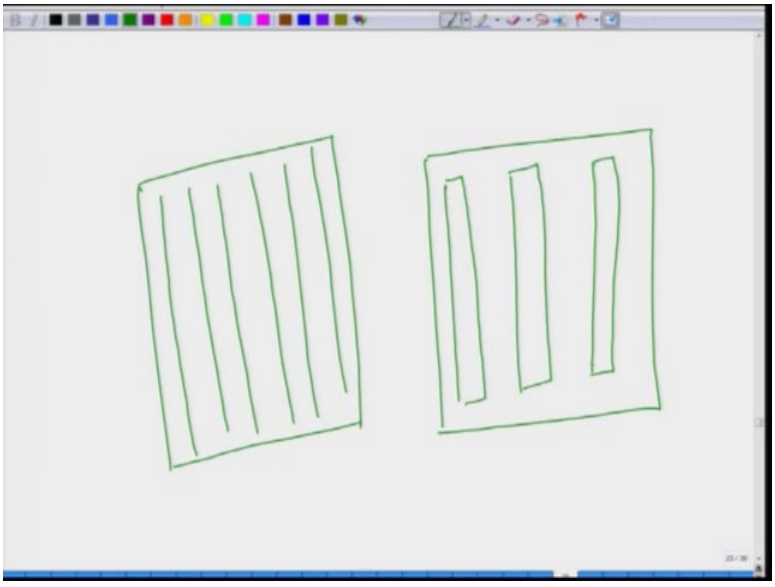

You can go for line sowing or strip sowing. So, in the case of line sowing, you have this area and you put your seeds in lines. So, you make a groove and then you put your seeds inside that groove on the soil. Or you can go for strip planting. In which case, you will create strips, and then you will put your seeds in these strips. Or you can go for patch sowing.

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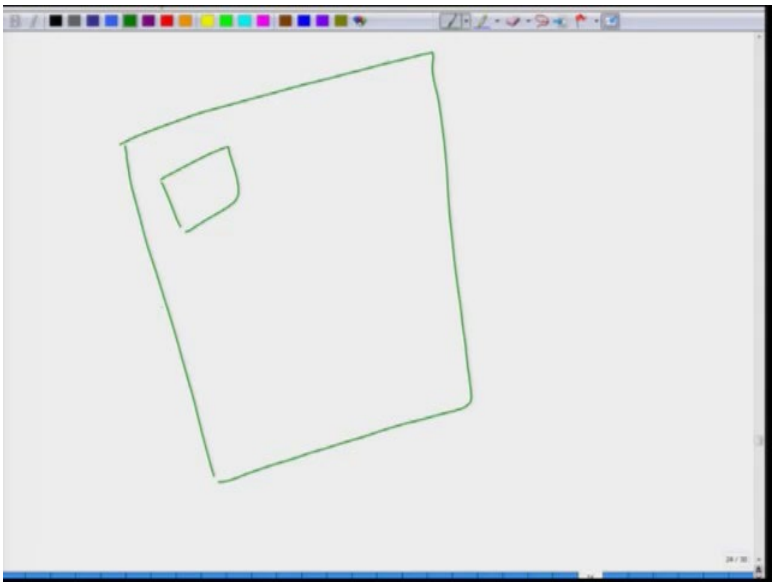

So, in the case of patch sowing, you will have this whole area; but you are doing your sowing only in a small patch. So, these are the different options that are available with you.

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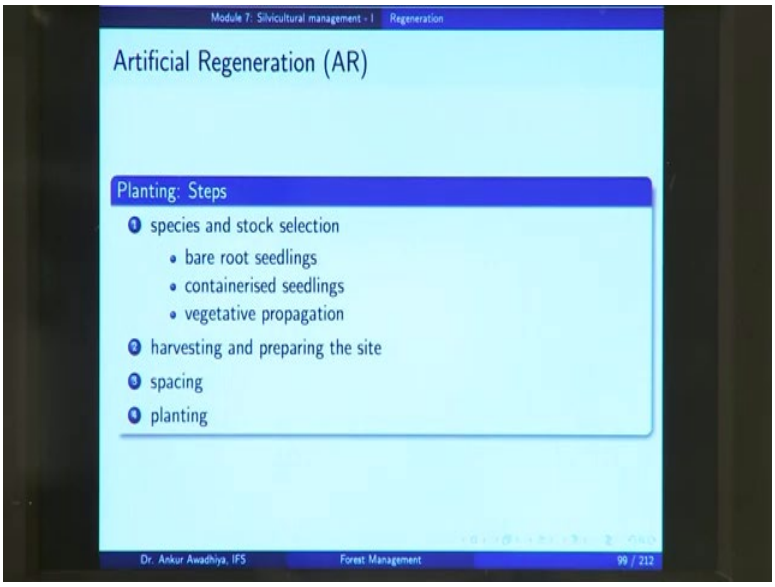

Now, we can also do artificial regeneration by planting. So, you can do artificial regeneration by sowing of seeds, or you can do artificial regeneration by planting of your seedlings. Now, when you are doing it through planting, there are four steps - one is the selection of the species and the stock. So, by species and stock selection we mean that,

your the species that you want to grow in your area should be such that it is able to tolerate the conditions in that area.

So, for instance, you cannot use a species that grows in a very warm climate on an area that is that falls in a very cold region, or vice versa. You cannot use a species that is tolerant or that is adapted to draught conditions in a waterlogged area, and vice versa. So, you have to go for a species selection.

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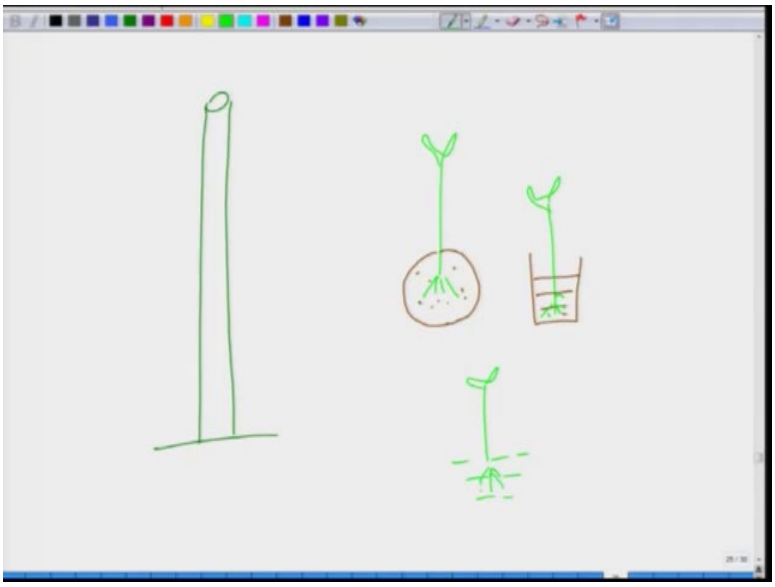

Next, you go for a stock selection. So, in the case of stock selection what we mean is that, if you want to have trees with tall cylindrical bowls, you select those mother plants that have tall cylindrical bowls. Because their seeds will be having these characteristics through genetics.

Once you have done your species and stock selection, you have got three different options to choose from. You can go with bare root seedlings. In the case of a bare root seedling, you have a seedling in which the root is exposed; you do not have any soil with this seedling. You just you just take it out from your nursery bed and then you put it in in the planting region. So, this is a bare root seedling, or you can go with containerized seedlings.

In the case of a containerized seedling, you will have this seedling, but it will also come with a with some amount of soil around the roots. And, this will typically be in the form

of a container. So, this you have this container that has the soil, and in this container, you have your seedling. So, you can go for a containerized seedling. Or, you can go for with vegetative propagation.

In the case of vegetative propagation, for instance, you can just take a twig from a plant and then you put it in to the soil. So, that after a while, it will start giving out the leaves, and the roots will develop; so, you can also go with vegetative propagation. So, this species and stock selection, you have these three options. Once you have selected your species and the stock, you can either develop them in the form of bare root seedlings or you can develop containerize seedlings, so, you can develop a vegetative propagation method.

Once your seedlings are ready, the next step is harvesting and preparing the site. So, in this case, after harvesting or the or the cutting of trees for timber, the preparation would consist of making holes in the ground where you are going to plant your seedlings. So, that is the site preparation, you might also want to add some amount of manures or fertilizers, or say insecticides or fungicides into the soil, then you also select your spacing that you want.

So, if you want to have your plants close by or do you want to grow them at a distance, so, that is also another management decision that you need to take, before you are making holes in the ground. And then, you go for the planting operation in which you put your seed in into the holes that you have generated.

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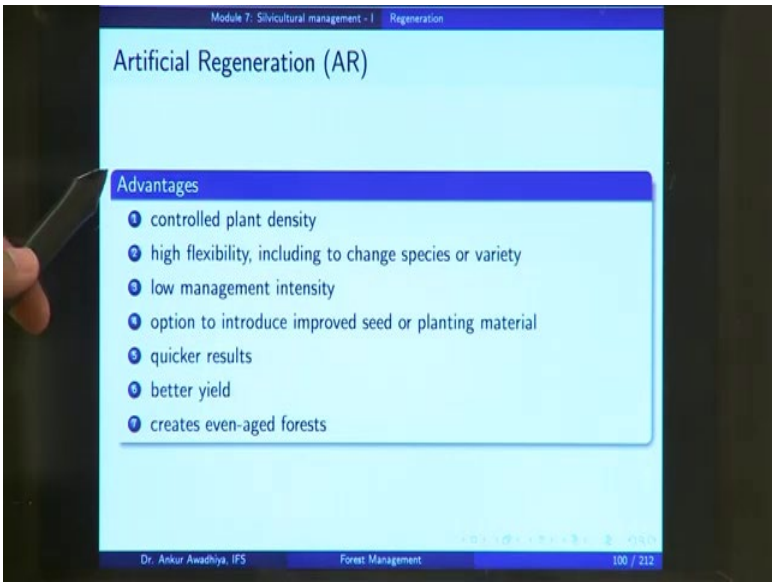

Now, artificial regeneration is preferred because it has a number of advantages. You have a very good control over the plant density. So, the number of plants that you will have per unit area of land is something that you can control yourself, because you yourself are making the pits in the ground. There is a high level of flexibility in this process including to change the species or variety. Because, everything is within your control. So, you have a good amount of flexibility.

There is low management intensity, because once you have planted this area, the only thing that you need to do after a while is probably some amount of weeding or some amount of casualty replacement, which is, which means that, if there is ah if you have planted a seedling and it dies out after a while, you just replace that seedling.

So, the amount of management intensity that is required in this region is very less. This option to introduce improved seed or planting material, which you did not have in the case of natural regeneration or ANR. The results are quicker, because in this case, the establishment also is quicker; because what you are doing is, you are taking your seeds; you are growing them in a nursery; you develop seedlings, and then you keep your seedlings in the nursery for say 2 or 3 years.

So, you already have very tall plants, and by the time you put them on the soil, they are already quite well established. So, you do not have to wait for them to develop more resistance against the natural adverse conditions. So, the establishment is very quick in

the case of artificial regeneration. There is also a better yield, and it creates even aged forest, because all the plants will be of the same age.

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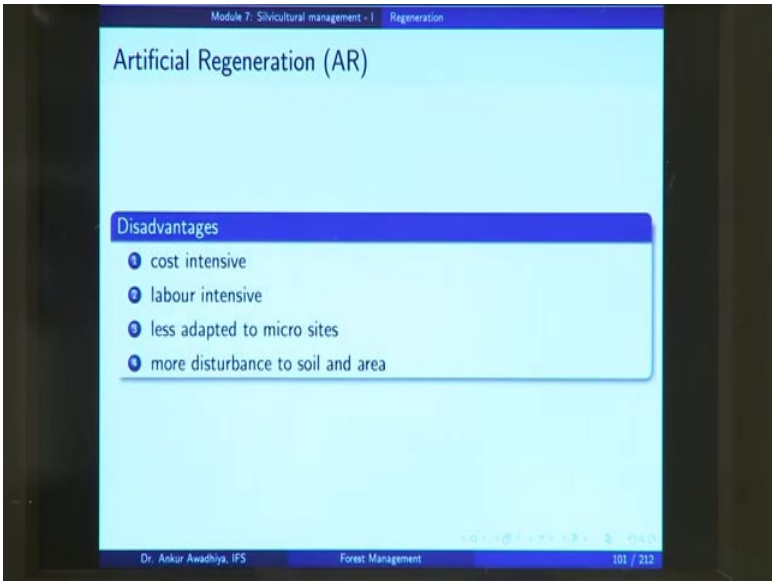

However, there are also certain disadvantages to artificial regeneration. It is cost and labour intensive, because everything is under your control; but also, everything has to be to be managed. So, you in the case of natural regeneration, you just left out a few trees and they developed their seeds, which germinated establish themselves. So, there was there was very little requirement of labour or money in in that process.

But in the case of artificial regeneration, you have to select trees; you have to collect your seeds from those trees; you will you have to treat those seeds; you have to germinate those seeds; then you have to grow them in a nursery; you have to tend for them; you have to care for them; you have to put water; you have to protect them against diseases and insects; and, you have to complete this process for the next 2 or 3 years. Once that is done, you have to dig holes in in the ground; you have to make pits; then you put your seedlings; there the planting operation also has to be done manually or by using equipment.

So, all of these require time; all of these require labour; all of these required costs. So, it is labour intensive and it is cost intensive. Also, it is less adapted to micro-sites, because it is possible that when you collected your seeds you, collected them from an area that

was facing a little amount of draught. So, your plants are those that are better adapted to draught like conditions.

So, the seeds that you collect from these areas will also generate plants that are better adapted to draught like conditions. But the final planting site might be one that is not having a condition of draught. On the other hand, it is having a waterlogged condition. So, in that case, it is and there is a good possibility that your plantation might fail.

So, there is very little amount of control over adaptation to the micro-sites. Also, it results in more disturbance to soil and the area, because you are disturbing the soil you are doing your pits. And when you are doing your pits, you are also keeping your pits for a while till your planting material comes to that area, and in that period of time, your soil is exposed to the sun; your soil is also exposed to or susceptible to erosion, because of air or water.

So, artificial regeneration, one disadvantage is that it leads to more disturbance to the soil in the area. But with all of these techniques and with all of this knowledge, now you can select which technique is the best suited for your species or for your area. So, in this lecture, we had a look at what is regeneration; how do we do regeneration; the kinds of regeneration, and what are the advantages and disadvantages of each and every of these techniques. So, that is all for today

Thank you for your attention [FL].