Forests and Their Management
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Module - 02
Basics of Silviculture
Lecture – 01
What is silviculture?

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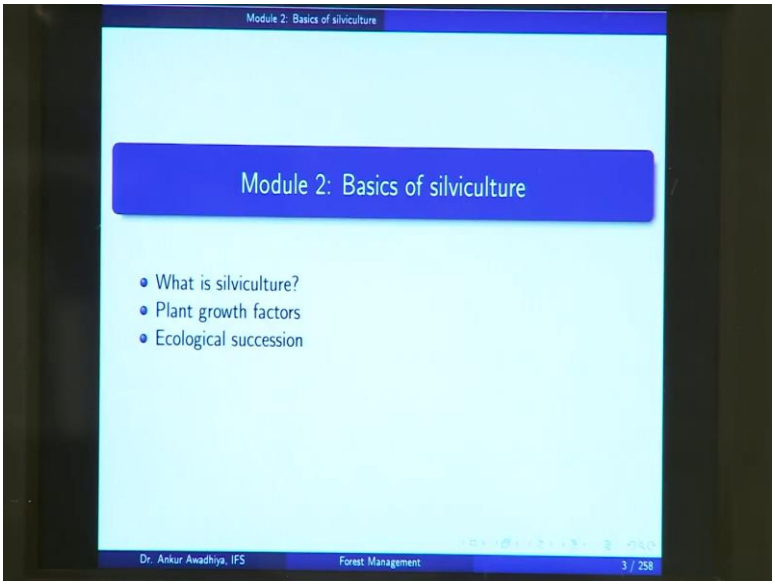

[FL] Today we begin the 2nd module, which is Basics of Silviculture. In this module we will be having 3 lectures - What is silviculture? Plant growth factors, and ecological succession.

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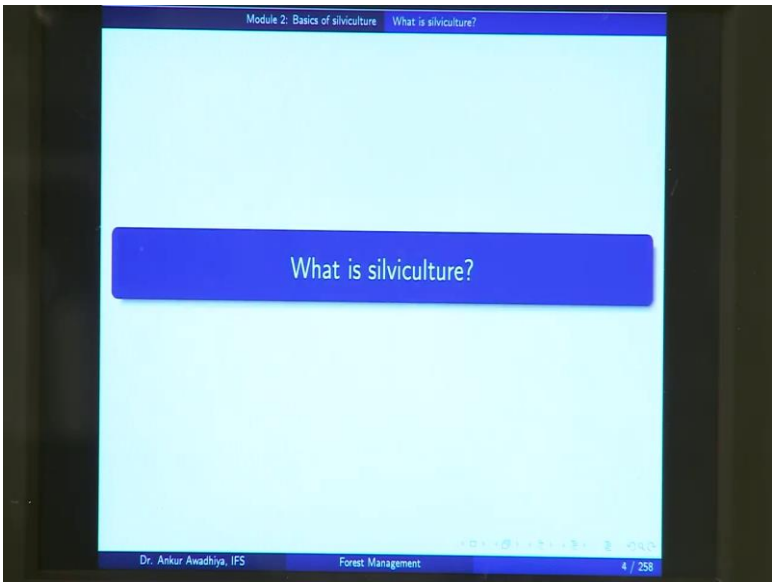

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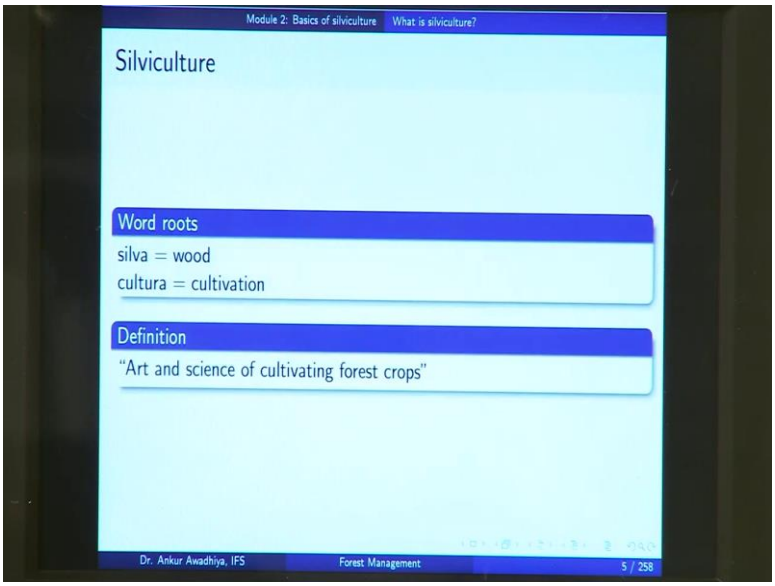

So, let us begin with W'HAT IS SILVICULTURE? The word silviculture comes from these word roots, "silva" meaning wood, or forest, or tree because we are getting wood out of trees, and "cultura" is cultivation. So, essentially silviculture is wood cultivation or this art and science of cultivating forest crops. So, when we talk about silviculture what we are trying to say is that we want to have a forest that is managed in such a manner that we are able to extract or cultivate wood out of it.

Now, this field of silviculture is intimately related with another field which goes by the name of SILVICS. Now, silvics is the study of life history or general features of forest crops with respect to environmental factors as basis for the practice of silviculture. So, what is it saying? It says that SILVICS is the study of life history of forest crops.

So, when we say life history the point of the question is, if we look at any particular species of tree or, if we are looking at any stand, how does this stand develop? So, for instance in the case of any tree it will start say as a seed, and then it will grow into a seedling, and then it will become a small plant, and then it will grow, and after a while it will become aged it, and then it will die.

So, this life history how much time is this is tree going to remain as a seed? How long will its life expectancy be? These are the things that go in the field of the life history of the forest crop. General features look(s) at things such as how do you identify these species in a forest? Or say how much is the amount of light that this plant requires?

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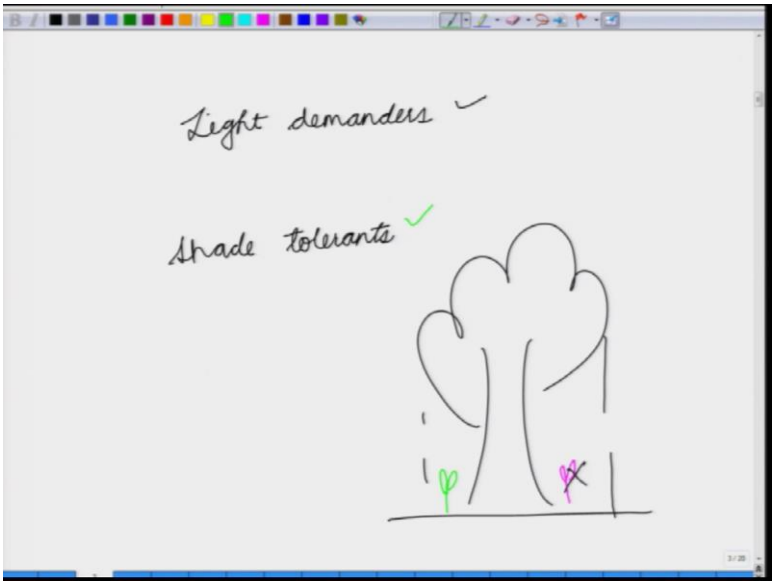

So, for instance, in the case of plants, we can have two different kinds; so, we can have light demanders, and we can have the shade tolerance. Now, light demander as the word indicates “is a species that requires quite a lot amount of light.” So, for instance if you have a forest if you have a tree and say if you grow or a light demander at this location where you are getting ample amount of shade of the mother plant.

So, in that case, this light demander will or may die out, whereas in the case of the shade tolerance, they are able to tolerate shade. So, they are able to grow in this location as well. So, silvics the study of "life history or general feature of forest crops with respect to environmental factors," so the next level of complexity is the environmental factors.

So, if we have a forest stand, if we are looking at a forest what is the impact of environment on this forest? Is also something that we study in silvics. So, for instance, if you have a stand of cheed pine plants, so cheed pine is a species that grows in mountainous areas or in cold areas.

Now, if there is an environmental change, so for instance, we are having a global warming these days. So, if the temperature of this location goes up what will be the impact on the stand? Is also something that we are going to study in silvics. So, we are looking at the life history or general features of forest crops with respect to the environmental factors, as a basis for the practice of silviculture.

So, why are we interested in knowing all of these? We are interested in knowing all of these because we want to make certain decisions. So, for instance, when you are having global warming; when temperature is going up at a particular location, and suppose you are planning to have a forest that has to be created, and you are going to extract wood out of it say after 90 years, or say 100 years.

So, in this period of 100 years, if we are expecting that the temperature is going to increase in this period, what are the species that we should plant in that area? Or for instance, if there, if because of your climate changes there is an increase in the extreme factor, such as draughts. So, should you go for the indigenous plants or should you go for some draught resistant varieties of these plants? - is also something that we are interested in knowing. But, we can only make these sorts of decisions when we actually know what is the impact of draught on each and every of these species.

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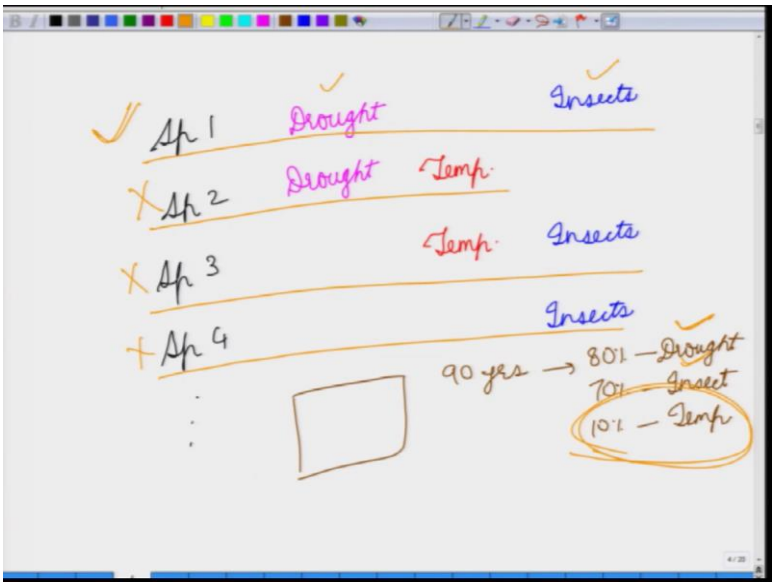

So, what we are trying to say is that you have species 1, species 2, species 3, species 4 and so on. Now, the first species is able to tolerate draught, and the second species is also able to tolerate draught. But you are having a situation in which the first species, if there is an increase in temperature it is going to die out. But, the second species is able to tolerate changes in temperature as well, and then probably you have a third species that is able to tolerate say - insects. So, there is an impact of insects, and you are having the situation. Now, when you know all these factors that - what is the impact of these different factors on different species, then only you can make a decision.

So, for instance, if you have a location in which in the period of 90 years, we are going to have say an 80 %probability of a draught, probably a 70% probability of an insect infestation, but say only a 10 percent probability that you are going to have an increase in temperature.

So, which of these species should you go for? If you say went for this species - species 2. So, there is a good chance of a draught it will be able to tolerate that, there is a good chance of an insect infestation, but then your species to will not be able to tolerate that. The species 3, if you have a situation of draught, it will die out; in the case of the species 4, you have draught and it dies out. But, in the case of species 1, it is able to tolerate draught, it is able to tolerate insects, it is unable to tolerate changes in temperature. But

then because you have a very low probability that there is going to be an increase in temperature at this particular location, you can go for the such species.

So, to make these managerial decisions, you need to know the characteristics of each and every of these species, and the characteristics of different forests - both in the native conditions and in the changed conditions. So, silviculture is the study of life history or general features of forest crops with respect to environmental factors, as basis for the practice of silviculture.

So, what is silviculture then? Silviculture is applied silvics. You are doing an application of all this knowledge that you have gathered in the field of silvics to grow your plants. So, that is - applied silviculture - is applied silvics is silviculture.

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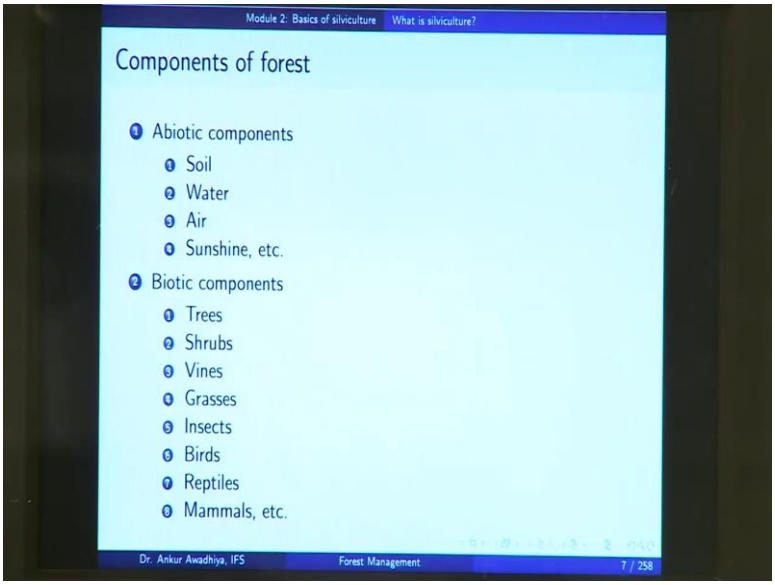

Now, in the case of silvics, we need to understand the impacts of all of these different components of forests on the characteristics of the forest. Now, forest happen to be biological communities, so they will be having abiotic components as well as biotic components. Now, abiotic component includes soil, water, air, sunshine and so on.

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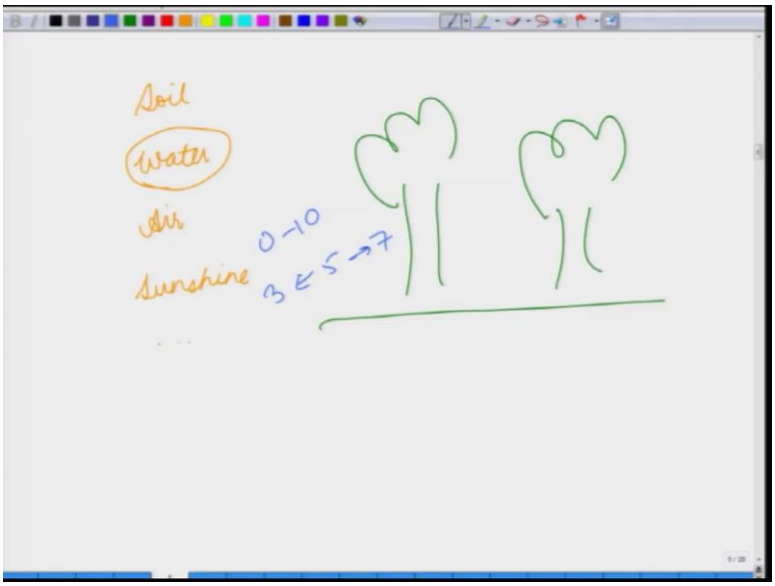

So, abiotic is non-living, so non-living components includes things such as your soil, water, air, sunshine and so on. Now, what is the impact of all of these? So, let us see consider the impact of water. So, you have certain species in your forest, and these species are able to grow at a presence of water that let us say on a unit of 0 to 10 you are having a level of 5, and these species are able to grow in this forest.

What will happen if this 5 becomes say 3 or it becomes 7? So, if you have a condition in which the amount of water is less, you will probably be having a draught like situation. So, what is the impact of a draught on these species? or if you are having an excess of water you probably have a situation of water logging or a situation of flooding. So, what is the impact of an increase in water on these species or these individuals, is something that we also study in silvics.

So, we study the impacts of the abiotic components as well as the impacts of biotic components. Now, biotic components include(s) trees, shrubs, vines, grasses, insects, birds, reptiles, and mammals. So, do you think that all of these will be having an impact on forests? So, let us see look at the impact of grasses.

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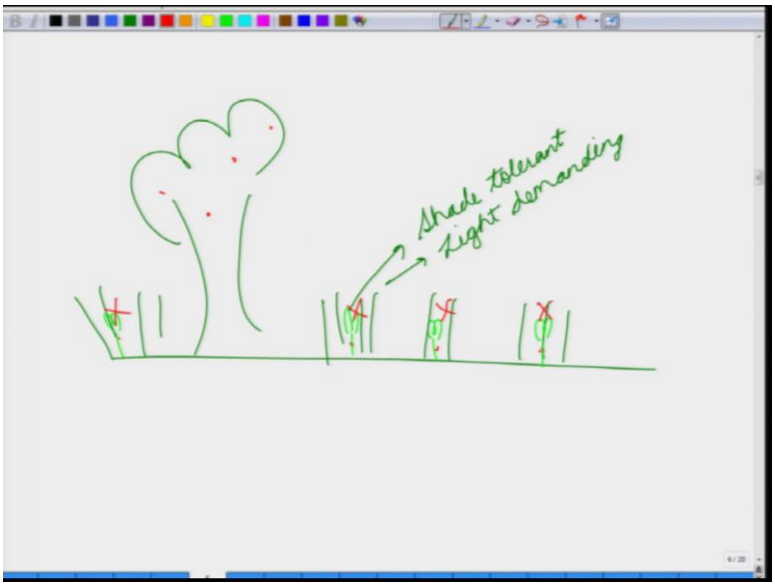

So, you have a forest in which you have seeds, and these seeds are now developing into seedlings, but in this location, we also have tall grasses. So now, the amount of sunlight that is available for your seedling, is controlled by the amount of grass. So, the length of the grass, or the height of the grass, and also the density of the grass that is impact sunlight - that is it seedlings.

Now, if your seedling is shade tolerant, in the, then it probably will be able to tolerate a much greater amount of grasses as compared to if it were light demanding. Similarly, if your seedling has a characteristic that is that it is able to better extract out water and nutrients from the soil as compared to the grasses, it will be able to out compete the grasses.

But, in certain situations you can have a situation in which the grasses out compete your seedlings, in which case your seedlings will die out. Similarly, if you look at the impact of another biotic component, say insects. So, there are a number of insects that feed on seeds. So, in that situation, you will have your seeds that are here on your trees and the insects eat them out or these seeds have fallen on the ground and then the insects devour on them.

So, this will have an impact on the forest. So, both the abiotic as well as the biotic components are integral parts of the forest, but they also regulate the forest and they are also important when we look at silvics or silviculture.

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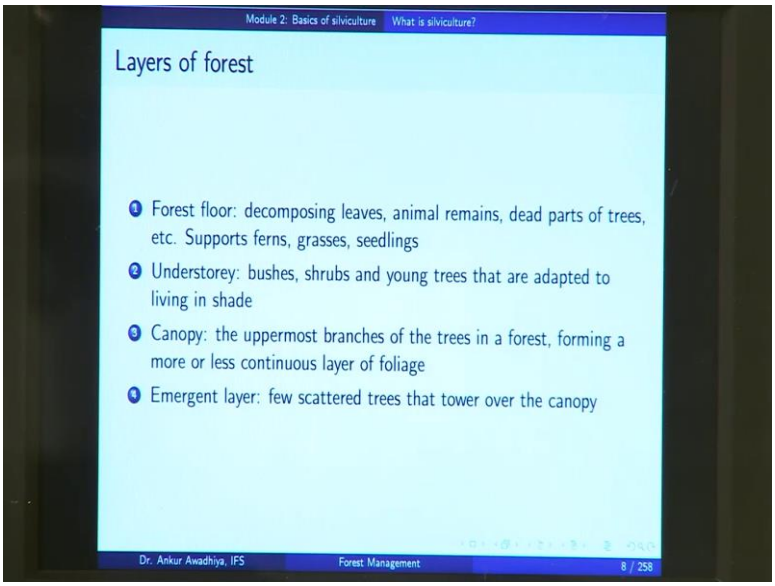

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The next concept is that of the layers of a forest. So, if you look at any forest, we will see probably four layers. So, here is your soil, then you will be having certain species that form a thick canopy. Now, canopy refers to the uppermost branches of trees in a forest that form a more or less continuous layer of foliage. So, canopy is something that you can think of as an umbrella.

So, in this forest, these plants are making a continuous layer on top, so this is a continuous layer, so this is the canopy. And, these trees will form the canopy layer, so

this is the canopy layer that is growing in your forest. But then you will also have certain species or certain individuals that are of a height that is less than the height of your canopy piece. So, probably you will have a plant that grows at this height.

Now, these plants typically will be shade tolerance, whereas your canopy was a light demander. So, your shade tolerant plants that are growing below your canopy layer from the understory. So, in this understory, you have a condition in which the amount of light is much less than what was available to the canopy plants because, these plants are growing in a shade like situation.

At the same time, the amount of wind pressure on these plants will be less, because they are surrounded by these canopy plants. Also, the amount of moisture that is typically present in this understory layer is much greater than what is present in the canopy layer. Because, in the case of the canopy, you have the sun that is leading to some amount of desiccation; it is leading to it is leading to transpiration from your canopy plants.

But, then these plants in the understory layer, they have a much greater amount of - they have a situation in which a much greater amount of moisture is present in the surroundings. So, typically the amount of transpiration in this layer is much lesser, Then, you can also have some plants that grow above your canopy layer.

So, there can be certain individuals that above the canopy, so these go by the name of EMERGENT LAYER. So, these are the plants that have a height that is greater than the canopy, and these individuals will have a much greater amount of wind pressure to tolerate. They will also have much greater amounts of desiccation that they should be able to tolerate, if they have to emerge out of these canopies.

Then the fourth layer goes by the name of - the forest floor. Now, forest floor typically will be having grasses; it will also have the leaf litter that is falling from all of these plants, whether the canopy plants, or the emergent layer, or the understory plant. So, it will also be having a huge amount of dead leaves or the fallen leaves. It will also be having some twigs, or some branches that have fallen down, and this layer which goes by the name of the forest floor.

Now, what are the kinds of switch of situations that this layer plants should be able to tolerate? One, they will be having very less amount of light. Because, any light that is

left out of the emergent layer and the canopy layer and the understory layer, is the light that is coming to these grasses.

So, the amount of light is very less, the amount of carbon that is there in the soil, or the amount of humus that is there in the soil is very huge. Because, all the leaves and the dead twigs are falling into this layer and they are decomposing. The amount of small animals or insects or microorganisms that these plants should be able to tolerate will be very high.

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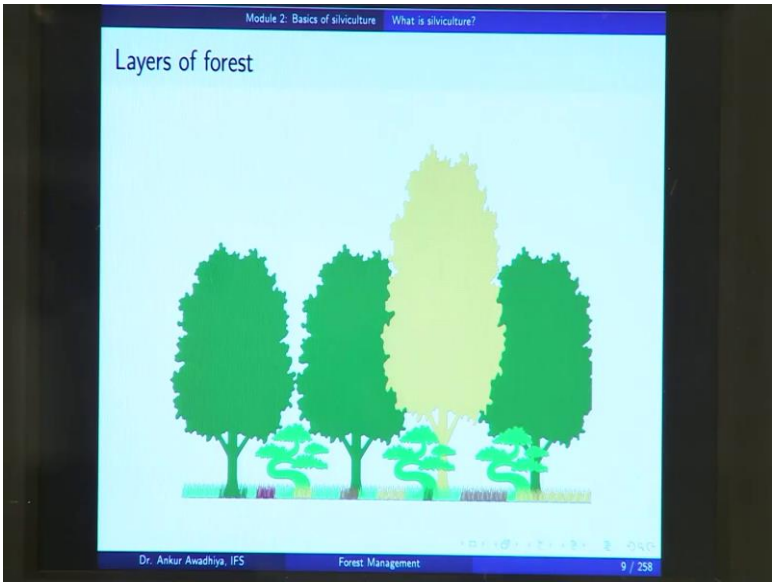

So, these are the four layers of the forest. So, you have the canopy layer, you have the emergent layer, you have the understory layer, and you have the forest floor that is typically comprised of grasses and hubs. Now, why do we need to understand all of this in the case of silviculture? This is because, when we go with silviculture, we will be having certain management objectives. Now, suppose your management objective is that you want to extract the maximum amount of wood from this forest.

Now, if you want to extract the maximum amount of wood, and you are, and you want it to be in a situation that you are able to extract it out in the most economical manner or in the most simplistic of manners. You will probably want to go with a forest that only has one species of trees. So, for instance, you would want to have a situation in which all your plants are teak plants.

So, in that case, you will have to construct a situation in which your emergent layer is gone, your understory is gone, and probably even you can let some grasses remain, or you will want to have a situation in which even your grasses are gone. Now, if you know the characteristics of all these different layers, you will be able to tinker on modulate your forests to meet your silvicultural goals.

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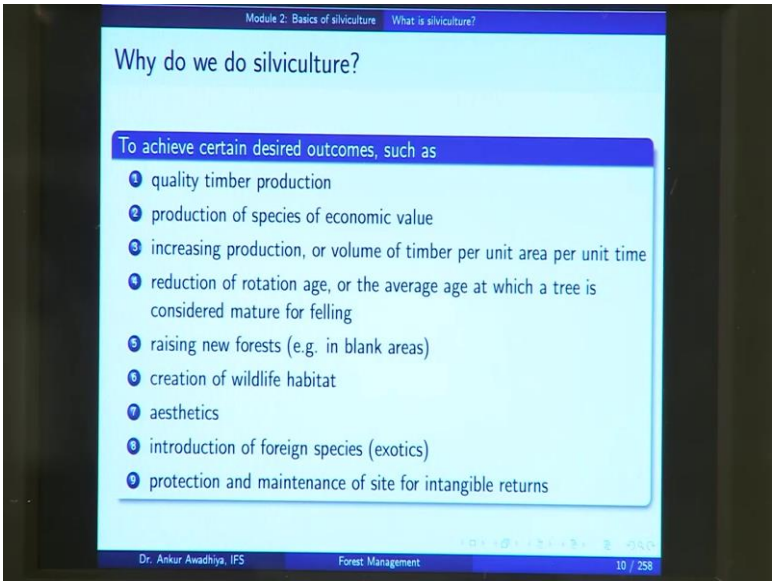

Now, what can be the other silvicultural goals? Why do we do silviculture? We do silviculture to achieve certain desired outcomes, such as quality timber production. Now, if your aim is to go for a quality timber production, you will probably want to go with monoculture. You will not want to have a situation in which you have a huge amount of biodiversity or different layers in your forests.

You will only want to have a situation in which all your plants belong to the same species, probably also of the same age. So, that the all your plants are having typically the same height and the same girth, so that will be, that can be one silvicultural objective. Another objective could be say - production of species of economic value. Now, if we look at this forest, probably you have different species that have different market values.

Now, for instance, you can have a situation in which these grasses probably they are medicinal grasses, and they have a huge market value; they have a huge market potential. So, in that case, your silviculture will comprise of a situation in which you will want to get rid of all these trees, and create a situation in which your grasses can grow in a

profuse manner, or say for instance, you have a situation in which you have some teak trees and say mango trees.

Now, the timber value or the economic value of the timbers from teak is much greater than the economic value or the cost of the timber from mango. So, you will want to have a situation in which you replace your mango trees and move towards the teak trees, so that can be another silvicultural objective. A similar silvicultural objective could be to increase your production or the volume of timber per unit area per unit time. Now, this could be say, because of your economic considerations or this could be as a way of mitigating your climate change.

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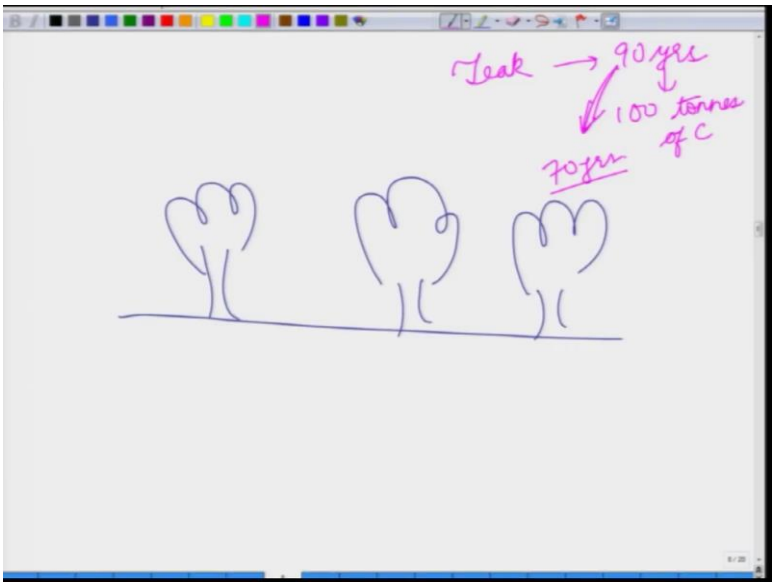

Now in the case of climate change, you are having more amount of carbon dioxide in the atmosphere, and you want to create a situation in which the trees that are growing in your forests are able to sequester or absorb all of these carbon dioxide, convert it into biomass and store it in their bodies. So, if you have this kind of an objective - to enhance your carbon stocks in the fastest possible times - that can also be one of your silvicultural objectives.

And that would require a very different kind of management, as compared to say, a silvicultural management for maximum economic production. So, for instance, you can have a situation in which you have teak trees, which typically say take 90 years to form, say 100 tons of carbon in their bodies. But probably you have say mango trees, which

say it take 50 years to form 100 tons of carbon in their body. Now, if your aim is to go for - say carbon sequestration, you will want to have mango trees in preference to your teak trees. So, what you want will depend on what is your silvicultural objective!

Now, another objective could be reduction of rotation age or average age at which a tree is considered mature for felling. So, in this case, what we are saying is that typically your teak trees are currently taking 90 years to reach the maturity. Can you do something to reduce it from 90 years to say 70 years? Probably, by say, putting more nutrients in the soil or going for better varieties of teak, so that you are able to reduce the rotation age or the maturity age. So, that can also be one of your silvicultural objectives. Now, in that case you will be managing your forests in a way that the faster growing trees are retained in this forest, and the slower growing trees are removed from this forest. So, that after a while you have individuals that grow faster, and in that case their progeny will also be individuals that have these characteristics of growing faster. So in that case, you will be able to convert your rotation age from 90 years to 70 years. Another silvicultural objective could be raising of new forest in blank areas.

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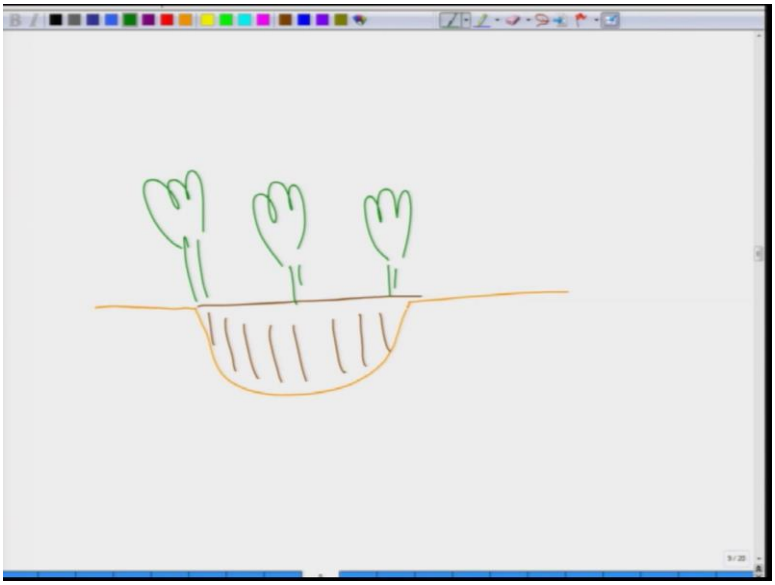

So, for instance, if you have a situation of a mine, so there was this land, which was then mined out, so there was mining that was done in this area. Now, after you have extracted out your minerals or the ores, you have a situation in which - you have this situation. Now, this area is a blank area, so it does not have any vegetation, whatsoever. So, you

can have a silvicultural objective to fill this area again with certain type of soil, and then re-grow your forest on top of this mined area. So, that could be one of your silvicultural objectives, and in that case the kind of management that you will do will be very different from the other kinds of management.

Another silvicultural objective would be or could be, the creation of wildlife habitat. So, probably you are doing silviculture not to extract wood, but to have the largest numbers of wildlife in your area. Now, wildlife will require a very different kind of situation than your timber production area. So, for instance, you can have this forest in which you have grasses, so you will have some grazing animals that are able to use these grasses. You will have canopy layer in which there could be some birds that make their nest in the canopy layer.

You will even want to retain your understory because, probably your understory is providing certain fruits to the wildlife. You will even want to retain the emergent layer because there could be certain species (birds) that only reside in very tall plants. So, if your silvicultural objective is to manage your forest for wildlife, you will go for a very different kind of treatment to the forest. Similarly, your one of your aims could be doing it for aesthetics, so in the case of aesthetics, you will do certain treatments such that your forest looks beautiful.

So, a beautiful forest in certain situations it could be going towards monoculture. So, that all your trees look of the same size and the same height, or in certain other situations you would want to go, if your aesthetic view point is to have a mixed sort of a forest, you can probably go for a mix sort of a plantation. So, that can also be one of your silvicultural objectives, or you can have an objective of introduction of a foreign species, or an exotic plant, such as eucalyptus.

So, when eucalyptus was introduced in the Nilgiris that was a silvicultural objective, or you, or one of your objectives could be protection and maintenance of a site for intangible returns. Now, what are intangible returns? These are the returns that you cannot see or feel with your senses; with your senses.

So, intangible return could be say - things like purity of air in your area, or reduced amount of pollution, or reduced amount of noise in your area. So, you can have a situation in which you are doing silviculture, so that you are able to protect or maintain a

site for the intangible returns. So, for instance, when we talk about planting of trees along the roadsides, that could be one of your silvicultural objectives.

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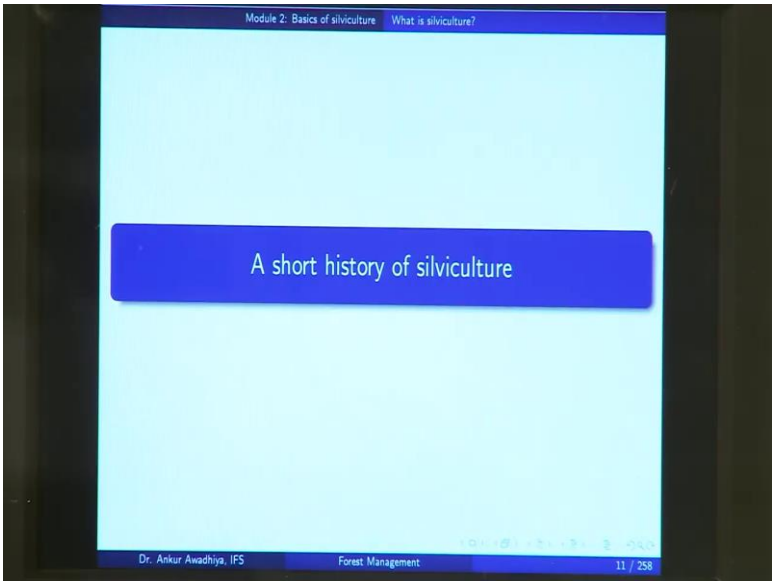

So, next let us have a look at a short history of silviculture. So, how does this, how did this discipline come into being?

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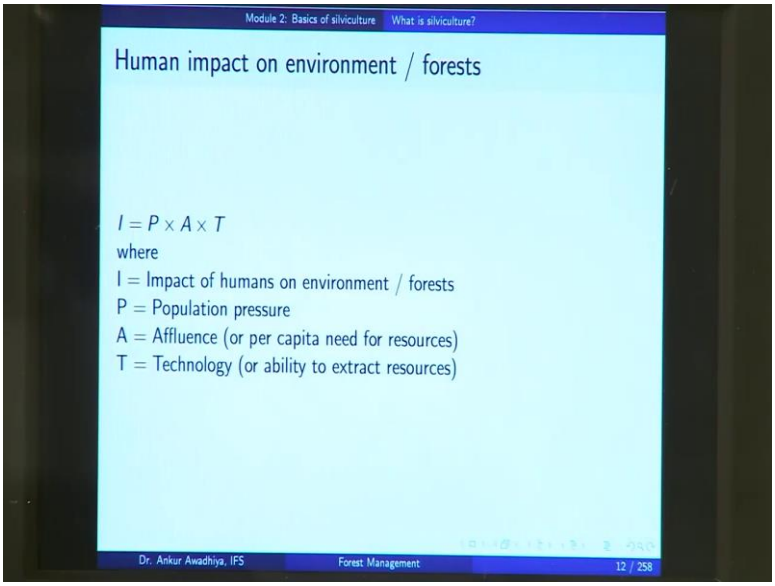

So, if we look at the impact of humans on environment of forests, we have this equation that

$$I = P \times A \times T$$

So, the amount of impact that humans will have on a forest, I goes, I refers to the impact is dependent on the population pressure, so more the number of people more is the impact of those people on the forest. A is the effluence or the per capita need for resources.

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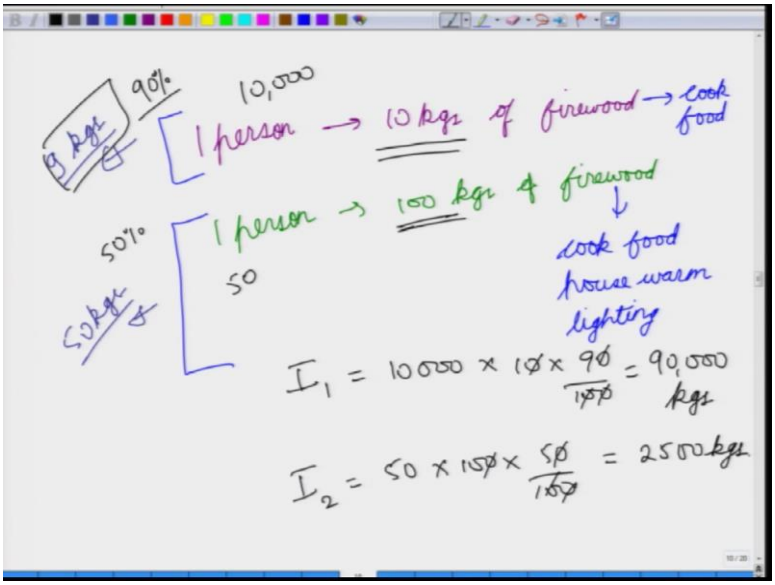

So, if you have a society, in which 1 person requires, say 10 kgs of firewood, and you have another society in which 1 person requires 100 kgs of firewood. Probably because in the first situation they were only using it to cook food, but in this situation, they are using it to cook food to keep their houses warm, probably also for the lighting of the nearby areas. So, in this situation, we will say that the amount of affluence of this society is greater than the amount of affluence of the previous society.

Now, more is the amount of affluence or the per capita need for resources, more will be the impact of this society on the nearby forests. Now, T refers to technology or the ability to extract resources. Now, probably in this situation, you have a society that requires all of these resources, but here you are only able to extract, so you require 10 kgs of firewood, but you are only able to extract 9 kgs.

And in this, in the second society, you have a lot more affluence, but even though they require 100 kgs of firewood, they are only able to extract say 50 kgs. So, this is another

factor that will govern the amount of impact of your society on the forest. So now, let us look at it in numerical terms. So, you had 10000 people each of them requiring 10 kgs of firewood, but the technological efficiency was only 90 percent, or was 90 percent.

Now, in this second society probably you have 50 persons each of them requiring 100 kgs of firewood, and the efficiency of extraction or the technological efficiency is here 50 percent. So, the impact of the first society is 10000 into 10 into 90 percent. The impact of the second society is only 50 persons into 100 kgs into 50 by 100. So, in this case you have 90000 kgs of wood extraction, and in this case, you have 2500 kgs. So, even though the second society has a much larger requirement of firewood per capita, the total impact is lesser. So, I = P x A x T.

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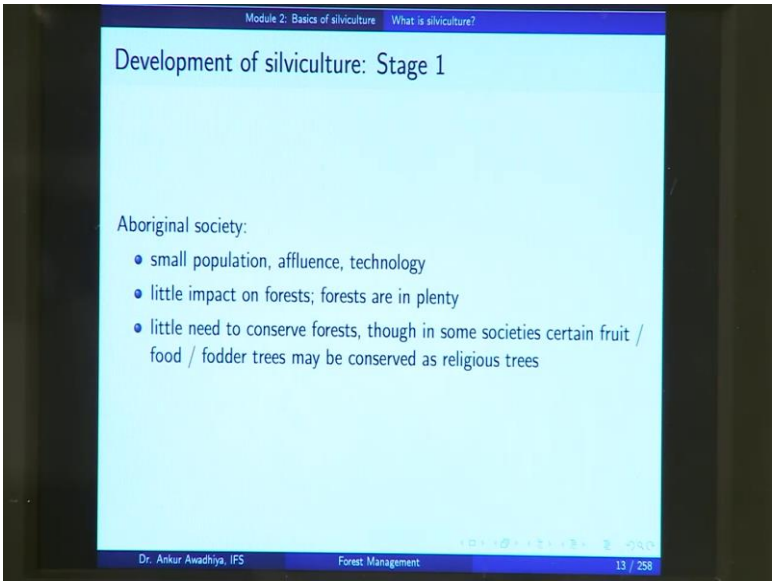

Now, if you look at primitive societies, so if we look through history, earlier you had aboriginal societies, so people were hunter, gatherers, and the population was very small. The requirement of word or resources was also very small, because in those days we did not have computers, we did not have large scale extraction of minerals, we did not have very good agriculture, we did not require or we did not have access to fertilizers or pesticides.

So, the amount of resources that one person needed was very small; the population size was also it very small, because it was the beginning of the civilization. And, the

technological ability to extract the resources was also very small, because we did not have access to the modern science and technology.

So, what was the impact of this society, so small population, small affluence, small technology, so there was a little impact on the forest, and the forest were in plenty. So, in those stages, there was no need for any silviculture. So, there was little need to conserve the forest, though in certain societies certain food or fruit or fodder trees may be conserved as religious trees.

So, in those days, people started worshipping those trees that were of utility to them. So, the only amount of silviculture was that if you have a fruit tree that was there in your vicinity, you protect that tree you do not cut that tree for firewood, but other than that there was hardly any need for large scale intervention, then with time there was modernization.

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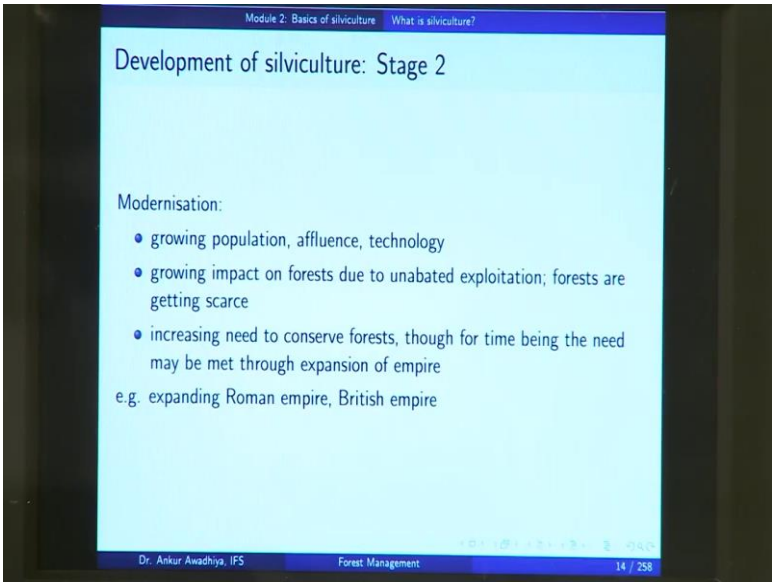

With modernization the population increased, the affluence increased, so with modernization you now require more amount of resources per capita. The technology also increased to extract these resources. So, the amount of impact of a modernizing society is much greater than the amount of impact of a primitive society.

So, with the growing impact on the forests due to unabated exploitation, forests started getting scarcer. So now, people started feeling that there was a pinch of resources or a

pinch of forest resources. But in these times, though there was an increasing need to conserve forests, people could go with an expansion of their empires.

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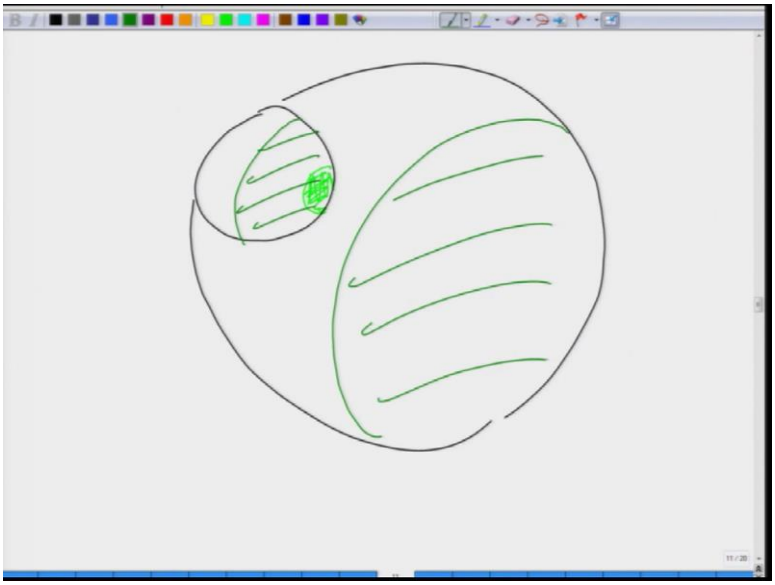

So, for instance, you had this much amount of in your land, you had these many forests. But, because of affluence and more use of resources, your forests are getting now scarce, so now, you have only this much amount of forest that is left. But what you can do is that you can expand your territory, and in that case, you can have access to the other forests that are available, so this was the second stage of the development of silviculture.

So, even though people started feeling that there is a dearth of resources, the forests are getting scarcer, the amount of conservation in increased a bit, but not to a very large extent, because, the needs were met by expansion of the empires for example, the expanding of Roman empire or the British empire.

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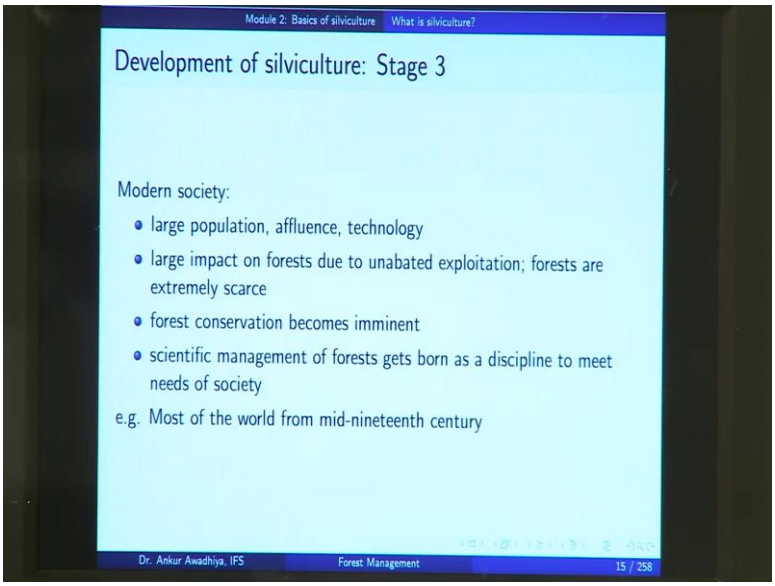

But, then after a while we reached the 3rd stage of the societal development, so the population has now increased. The affluence is large; the amount of technology is large; the amount of impact on the forest is also very large. But now, you do not have any more areas that are left for increasing your expansion or the exploitation of the forest. So now, you are having a situation in which the impact is very large, but you do not have newer areas in which you can go and extract the resources.

So now, there is a pinch period in which you do not have any other option than to manage your forest in a scientific manner, so that you are able to increase your productivity. So, now in this stage, the forest conservation becomes imminent, and the scientific management of forests gets born as a discipline to meet the needs of the society. So, if you consider, say the British empire in the beginning, they had very less number of people, there was hardly any impact. Then when the society started to become more modernized, they started expanding their empire, they reached India, and they started exploiting the forests of India.

So, when in those days, for instance, the ships were made out of wood, so there was a very large-scale extraction of wood that was done in India, and all of that timber was then moved to the - to Britain. But, then after a while your exploitation has grown to such an extent that now no more trees are left in India, what do you do then or very less number of trees are left in India.

So, then the Britishers started thinking what we can do is to increase the number of trees that are there in the forest. How do we do that? They started to think should I cut a tree when it is say - 10 years of age in which it has reached its height, but the girth is very small, or should I wait for say 20 more years, so that the thickness of this tree also increases.

When is a good time to cut this tree? When is a good time to plant a tree? What are the resources that are required by a tree to grow?

So, when you start thinking about all of these different factors, then you are moving towards a scientific discipline of silviculture. So, most of the world from the mid-nineteenth century is in this stage.

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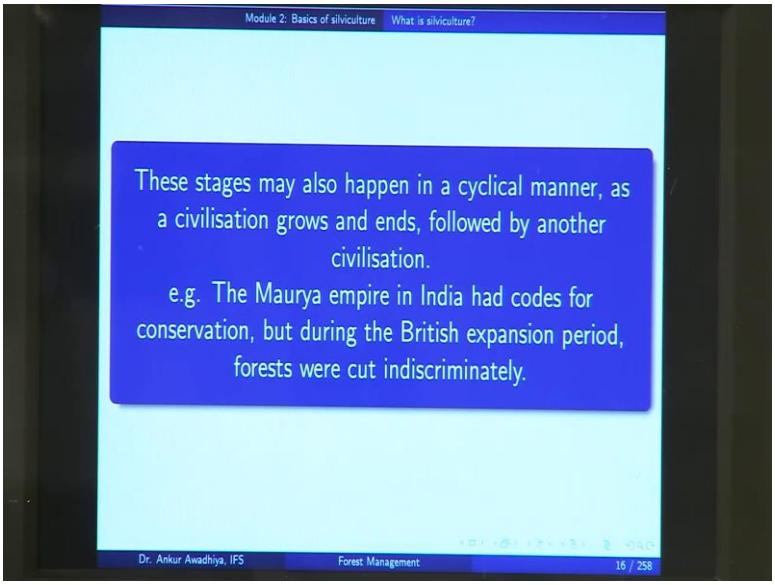

Now, these stages or these stages of development of silviculture can also happen in a cyclical manner, because societies go - move from an ebb to a tight. So, for instance, if you look at the Mauryan civilization - the Mauryan empire - they had strict codes for conservation. But then I after a while when we had the British period, they moved towards the expansion period, and the forests were cut indiscriminately. So, you can also have a situation in which an earlier society is putting much more emphasis on conservation than a later society. So, these things can also move in a cyclical manner.

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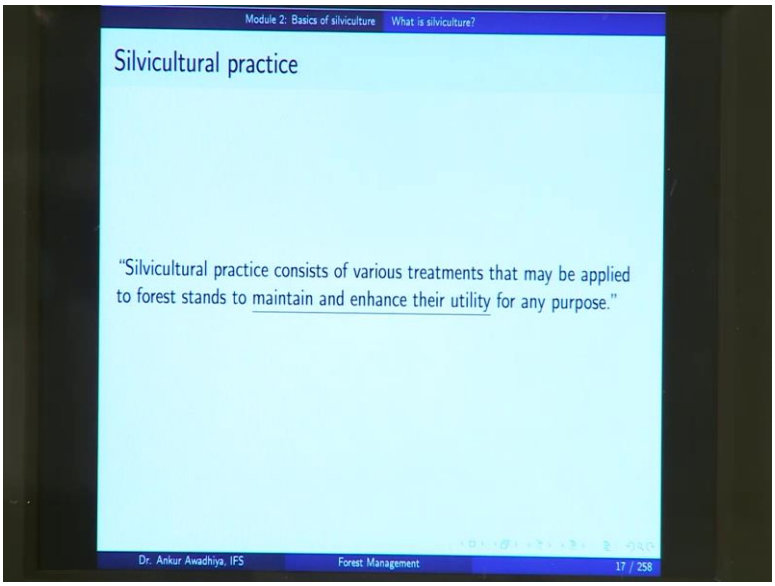

So, that was the short history of silviculture. Now, how do you do silviculture? So, silviculture is done through silviculture practices that are made into silvicultural systems. So, what is a silvicultural practice? Silvicultural practice consists of various treatments that may be applied to forest stands to maintain or/and enhance their utility for any purpose.

So, a practice is a treatment that you are given to a forest stand. What can be a treatment? A treat can - a treatment may mean say cutting of trees, or say cutting of the climbers that are growing on a tree, so all of these things are silvicultural practices. Another practice could be to go with an artificial regeneration of forests; you go into a forest and you plant start planting trees. So, all of these things are silvicultural practices. They are treatments that are applied to forest stands.

Now, why are you applying these treatments? To maintain these forest stands, to maintain the utility or to enhance the utility, for any purpose. Now, what are these purposes? These purposes are the silvicultural objectives that we looked at before. So, your objective could be to extract more amount of timber; your objective can be to have biodiversity in that area; Your objective could be to maintain it for aesthetic reasons. But given those objectives, what are the treatments that you are applying to this forest to maintain its utility or to enhance its utility goes by the term of silvicultural practice, and a set of practices forms a silvicultural system.

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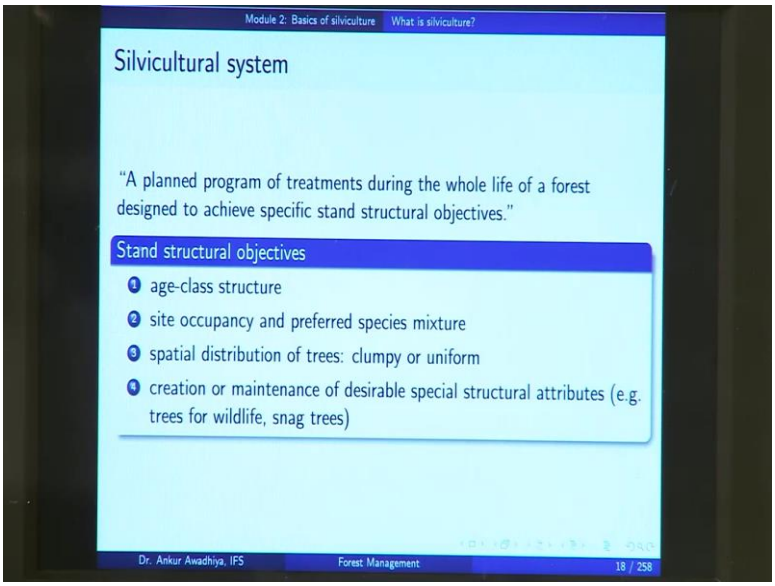

So, a silvicultural system is a planned program of treatments during the whole life of a forest designed to achieve specific stand structural objectives. So, you have these treatments, but then when do you give these treatments. So, for instance, one treatment is to plant trees.

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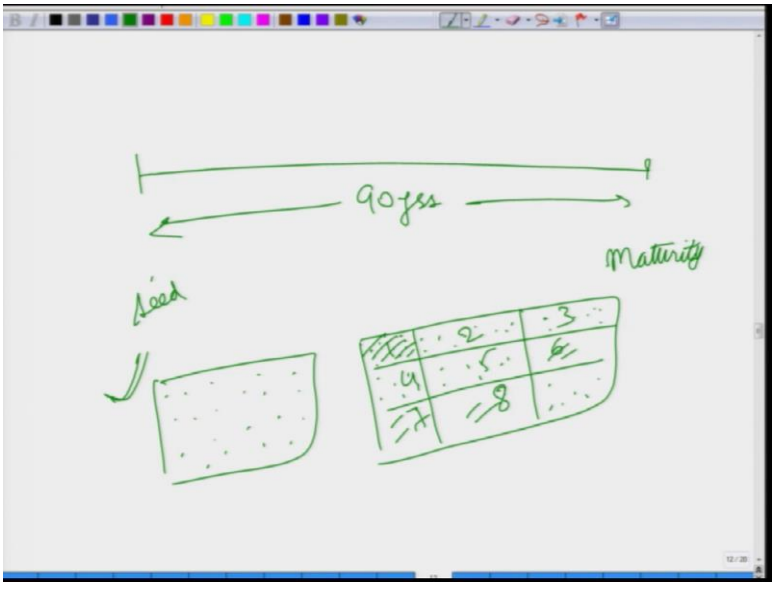

So, when should you plant a tree? You have a forest and you are going to cut this forest for a period of say 90 years. So, in a period of 90 years, your plant moves from a seed stage to a maturity stage. Now, in the case of a forest, suppose you have this piece of

land, should you say go with seeding in all of this area or planting in all of these areas. And then, you wait for 90 years and then you cut these forests. Is that what you want to go for? Or for instance, you have this forest and you divide it into four sections. You are going to plant this section in the, so you have these four sections, and or let us divide it into 9 sections.

So, for the first 10 years, you are going to plant the section, then you are going to leave this area, then you cut another section, and then you plant this area, then you cut here. So, earlier you had trees everywhere, and now what you are doing is you are cutting trees in one ninth of the forest, and then planting seeds, then you cut trees in this one ninth of our forest and then you plant the seeds.

So, that when you reach from 1, 2, 3, 4, 5, 6, 7, 8, 9, so when you reach at this stage. So, you have cut this forest, and you have planted the trees. You have a situation in which the forest of the first section have now reached to a maturity stage. So, if you go with this kind of a system, probably you will be having a work at every point of time.

In this section or in this system, you had a situation in which you planted the whole of the area, and then you had nothing more to do in the next 90 years. And at the end of 10 years, you again have a huge amount of work to do to cut these trees, and to plant it again. In this system, you have divided your work in a temporal fashion, so the silvicultural system is a set of all of these different management options that you have.

So, the silvicultural system is a planned program. So, you are doing a planning of when to apply which silvicultural practice. It is a planned program of treat - treatments during the whole life of a forest, designed to achieve specific stand structural objectives. Now, what can these objectives be? They can be to achieve a certain age class structure. Now, what do we mean by in age class structure?

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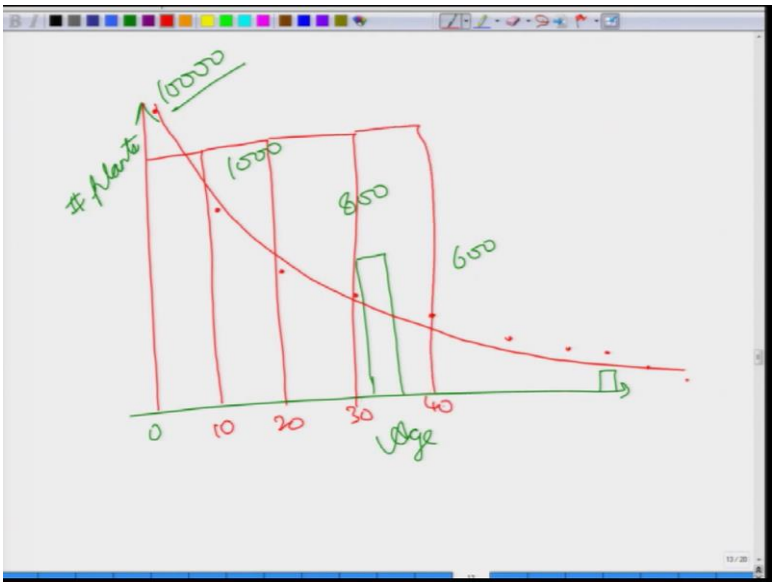

So, if you look at a forest, if we have, and this is the number of plants. Now, typically the number of seeds or the number of saplings that are from the age of 0 to 1 will be very large; so, you have large number of small plants. Now, in the middle stage, you probably have less number of plants, and in this stage, you have a very less number of plants.

Because at every stage, you are going to have certain amount of mortality, so for instance, you started with 10000 plants. So, you have 10000 small plants, but then these plants are also getting eaten up by insects or probably by mammals - the herbivores they are eating up these plants. So, at the end of 1 year, you say - are only left with 1000 plants. At the end of the 2nd year, now your plants have become a bit taller, and they are now known what the preferred species.

So, at the end of the 2nd year, out of these 1000 plants, probably you have lost only 200 plants and 800 plants remain. Now, as these plants are now increasing their, in the ages, the amount of resistance that they can give to an organism that is trying to eat this plant or is trying to attack this plant, will go on increasing.

But still you will be having certain diseases that these plants are subject to. So, at the end of say 5 years, in place of 800 plants only 600 plants remain. Now, you will, so in this situation you have a case in which the number of plants was very large to begin with, then it drops and drops and drops, and after a while you have a very small number of plants that remain, and the number of plants becomes constant.

But then you also are having some certain amount of mortality, because the age is increasing. You have plants that are of an older age and they are dying out, because of the age factor. So, you have this sort of a curve. So, this is a certain age class structure that is present in a natural forest.

But now if you want to manage this forest, if you want to cut timber or extract timber out of this forest, you would want to have a situation in which probably, for a certain section of the forest, all your trees are of the same size, the same height, and the same diameter. So, in that case, you want to shift from this sort of section to a forest in which you have these many trees that are from say 0 to 10 years of age. The same number of trees that are from 10 to 20, the same number of trees that are from 20 to 30, the same number of trees that are from 30 to 40 and so on.

So, this can be your stand structural objective to achieve a certain age class structure that may be a natural age class structure or a modified age class structure. Or, your stand structural objective could be to change the site occupancy in the preferred species mixture. To give an example, you started with a natural forest in which you have say 20 different kinds of species of trees. But, only two of those 20 species are off, and of a commercial value.

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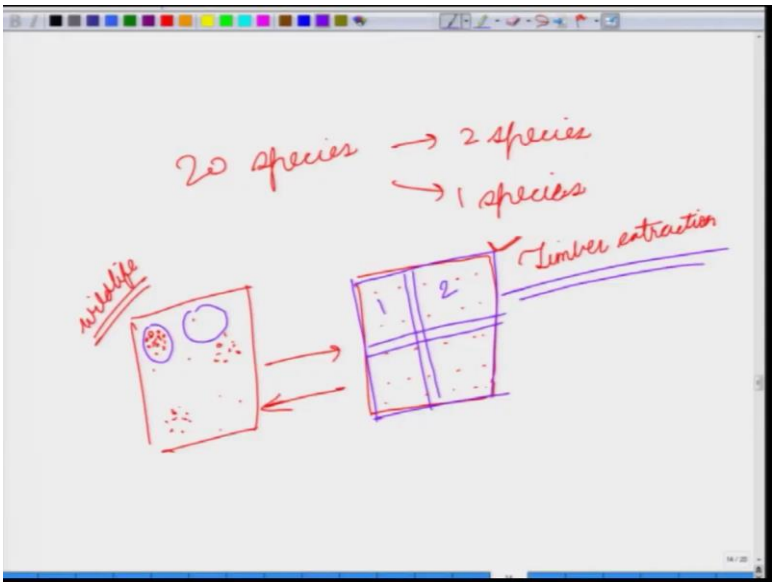

So, you want to change your forests, so that in place of 20 species, you have only 2 species, or you have only 1 species, in which we case in which case we call it a

monoculture. So, that can be your stand structural objective to change the preferred species mixture to change the site occupancy of these trees. Or, you want to have a stand structural objective to change the spatial distribution of trees from clumpy to uniform or vice versa.

So, in the first case, you have a situation in which you - so this is your forest, and these are the trees. So, trees here, you have a group of trees here, you have a group of trees here, and in the other areas there is a very small number of trees. So, you have a clumpy distribution of trees. You probably want to change this into a situation in which your trees are uniformly distributed in the whole forest.

So, this can be another of your stand structural objectives. So, you would want to convert it into a uniform distribution, if you are trying to extract it for timber. Whereas, if you want to manage this forest for wild life, probably, you would want to move towards this forest. Because in this case, you will have certain species that live in these clumps; there are certain species that live in these grass lands, which have less number of trees.

So, again changing of this spatial - spatial distribution of trees can be your one of your stand structural objectives. Or, another objective could be the creation or maintenance of desirable special structural attributes, such as trees for wildlife, or snag trees. So, in this case, what you are saying is that your objective is to have certain special trees such as a snag tree. Now, what is a snag tree? A snag tree is a tree that is, that probably is, of a large height, but more importantly, it is probably - a dead tree.

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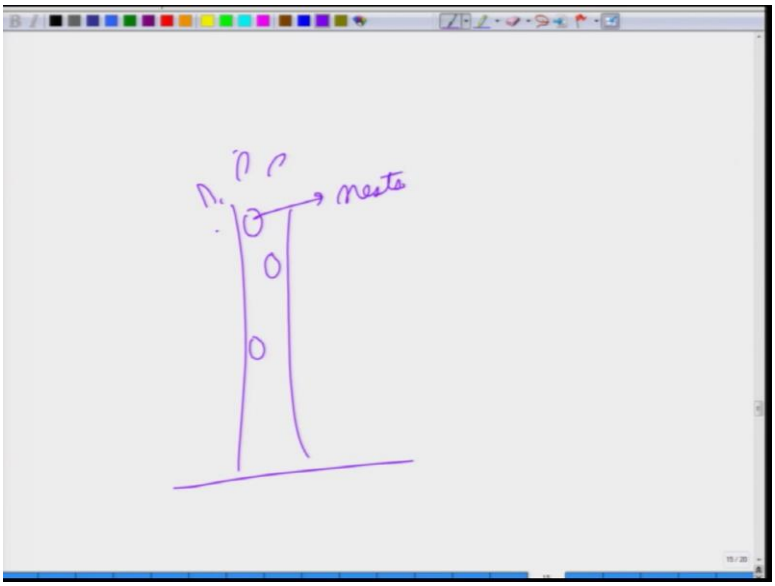

So, in this tree you have hardly any leaves that are here, but then you have certain hollows that have formed in the timber. Now, these hollows can be used as nesting sites for certain species. So, your specific your stand structural objective could be to create these trees with these special attributes, or to maintain these trees with these special attributes, so that can be another of your stand structural objectives.

So, your silvicultural system is a planned program of treatments during the whole life of a forest designed to achieve specific stand structural objectives. Now, when you are trying to achieve these objectives, you will also have to look at certain other branches of forestry.

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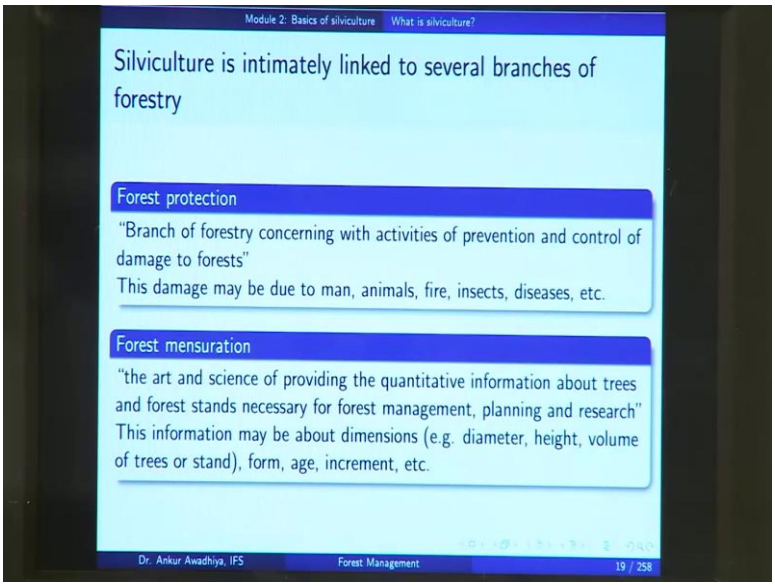

So, they are intimately linked with silviculture. One such field is forest protection or the branch of forestry that concerns with the activities of prevention and control of damage to the forest. This damage may be due to man, animals, fire, insects, diseases etc. So, what we are saying here, is that you are trying to maintain this forest for timber extraction.

So, you wanted to have this forest, but then your forest had a forest fire, and all of these trees got burnt, so that is not a desirable situation. So, in that case, apart from having this spatial distribution, you will probably want to have certain fire lines. So, these are the sections in which you are not growing any plant, so you are leaving these portions of soil denuded, so that your fire is not able to jump from this section to this section.

Now, when you are, when you are incorporating this feature into your forest, even though it was not a part of your stand objective, you are doing this, because you want to protect your forest. So, forest protection and the concepts of forest protection will be intimately linked to silviculture. Another field that is intimately linked this forest mensuration, mensuration is measurement.

So, forest mensuration is the art and science of providing the quantitative information about trees and forest stands, necessary for forest management, planning and research. This information may be about dimensions – Example, diameter, height, volume of trees or stand, form, age, increment etc.

So, we will, we are going to look at these points, when we look at the module on forest mensuration. But what this is saying essentially is that, if you are unable to measure your forest you will not be able to manage them. What cannot be measured, cannot be managed. So, for instance, you want to manage your forests to have the maximum amount of carbon sequestration. But, if you do not know what is the amount of carbon that is sequestered in your forest, how are you going to manage it?.

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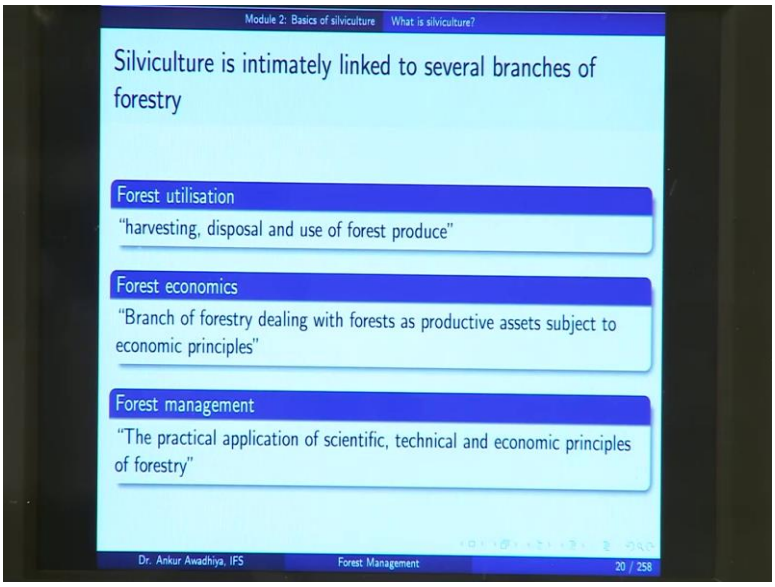

So, forest mensuration is an integral part of silviculture. Another is forest utilization or the harvesting, disposal and use of the forest produce. You are trying to harvest the forest produce, you want to dispose it off, in a market you want to use it for certain purpose, if you do not know how your forest or timber is going to be utilized, you will not be able to manage it properly.

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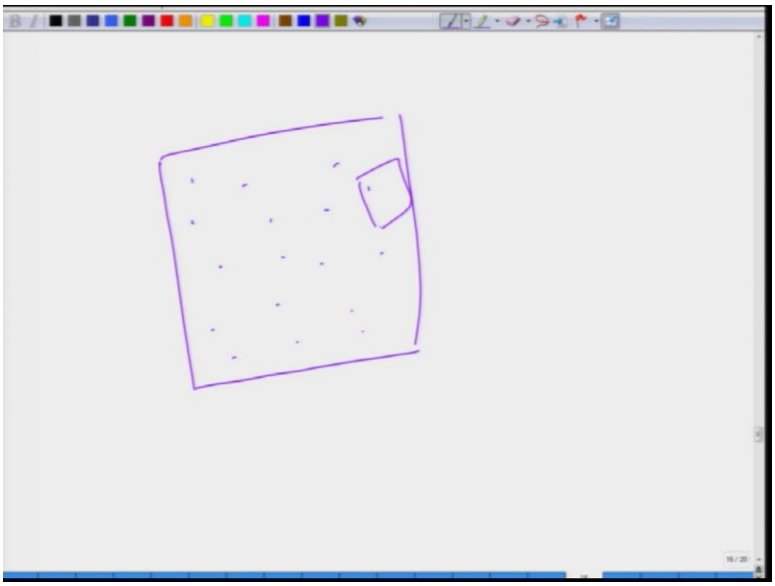

So, for instance, you want to have a forest, and in this case, probably you are going you are trying to extract your timber using large sized machines. Now, if you want to use these large size machines, you will have to incorporate into your silvicultural system something that permits your large size machine to enter into this area. And, something that protects the small seedlings or the saplings from the impacts of these large size machines. So, if you do not know how your forest is going to be utilized, you will not be able to manage it for your silvicultural objectives.

Another branch is forest economics, or the branch of forestry dealing with forests as productive assets subject to economic principles. So, your silvicultural objective was to have the largest amount of money that you are able to earn from these forests. But, if you do not know how to value these forests, how to do a cost computation of your inputs and the outputs, how are you, how will you select a system that is able to provide you with the maximum economic returns.

So, forest is economics is also a branch of forestry that is intimately linked with silviculture, also forest management or the practical application of the scientific technical and economic principles of forestry. So, you wanted to manage your forest, for say carbon sequestration, for that you want to plant certain species; you want to plant them at certain periods of time. So, there is no way in which you can overlook things such as human resources. So, you will have to recruit certain people; you will have to train those

people; you will have to provide them with certain resources. So, this portion that technically goes with the field of management is also something that you will have to study and implement, if you want to - objectives. So, all of these branches are intimately linked to silviculture.

So, silviculture or the cultivation of trees or the cultivation of a wood is a field that requires the knowledge of silvics, which is the study of the life history of the plant growth. It is also something that requires a knowledge and application of all of these different fields of forestry. So, this is the basics of silviculture, and we will build on these topics, in the next lecture.

Thank you.