Forests and Their Management
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Module – 10
Silvicultural Practices
Lecture – 28
Seed Collection and Treatment

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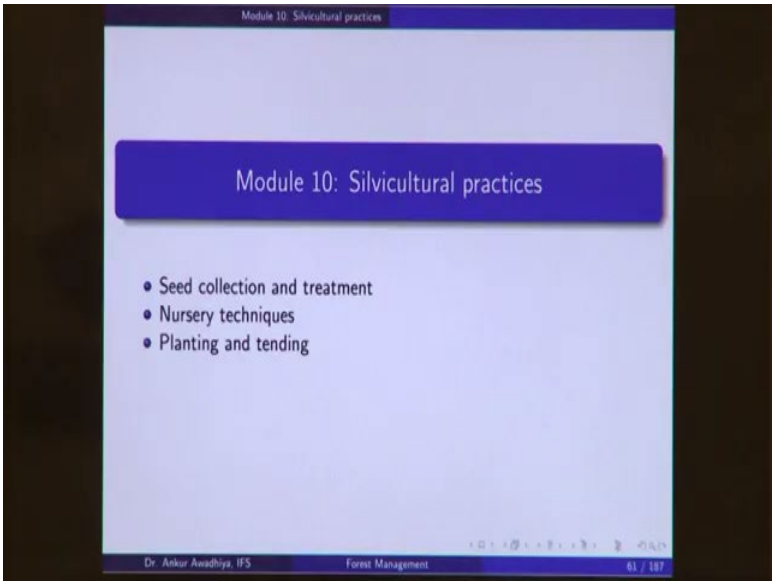

[FL]. Today, we begin a new module which is Silvicultural practices. This module will have 3 lectures. The first one is seed collection and treatment, followed by nursery techniques, and planting and tending. So, let us begin with seed collection and treatment. Now, we all know that a number of plants originate from seeds. So, if you want to use plants; if you want to raise plants, and plant them say, in the case of artificial regeneration or assisted natural regeneration, you need to begin with seeds.

So, we have 2 options; you can begin with seeds or you can begin with vegetative propagation. But typically, beginning from seeds is much cheaper and is much faster, as compared to doing a vegetative propagation. So, in for a number of species, we collect seeds; we treat those seeds; we convert them into saplings, and then we plant them out in the field.

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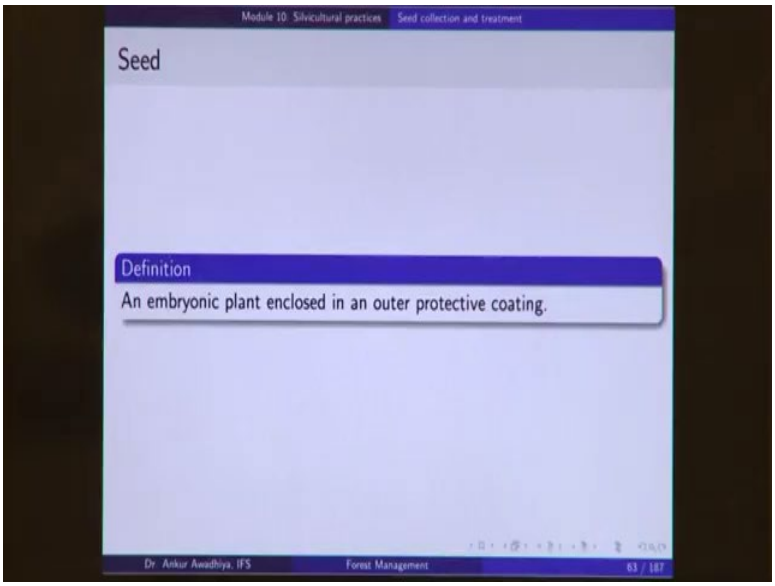

So, let us begin with what a seed is; A seed is defined as, “an embryonic plant enclosed in an outer protective coating.” So, it is an embryonic plant. This is not a plant which is well-developed; this is in an embryonic form. It is enclosed in an outer protective coating. And, why is it enclosed in outer protective coating? Because, if you consider these, very these embryonic plants, then there are a number of organisms; so that would want to eat up these plants.

And so, to protect itself, the seed has a protective coating around itself, which is typically very hard and which is typically non-digestible. So, even if an animal eats up a seed, this seed will pass through the digestive system and it will come out along with the excreta, and then, it will germinate itself.

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So, this is how seeds typically look like. So, here is a fruit and within this fruit, we are seeing these seeds. So typically, when this fruit will open up, these seeds will become exposed and then, they will fall down and then, they will start to germinate naturally.

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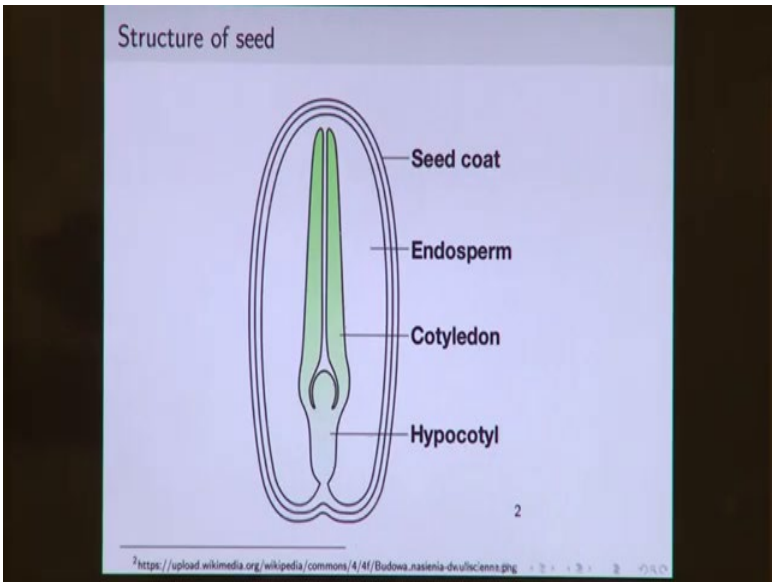

If you look at the structure of a seed, this is what a seed a looks like. So, here you have the seed coat which is the outer tough layer that protects the seed. Endosperm is the food for the embryonic plant then it is able to formulate its leaves, until it is able to start the process of photosynthesis through which it will be making its own food. But till the time

that these leaves are formed; they come out; they get exposed to the sun; so, till that time, the plant needs energy and that energy is provided by the endosperm. Cotyledons are the leaves of this developing plant, and hypocotyl is the part that is below the cotyledons.

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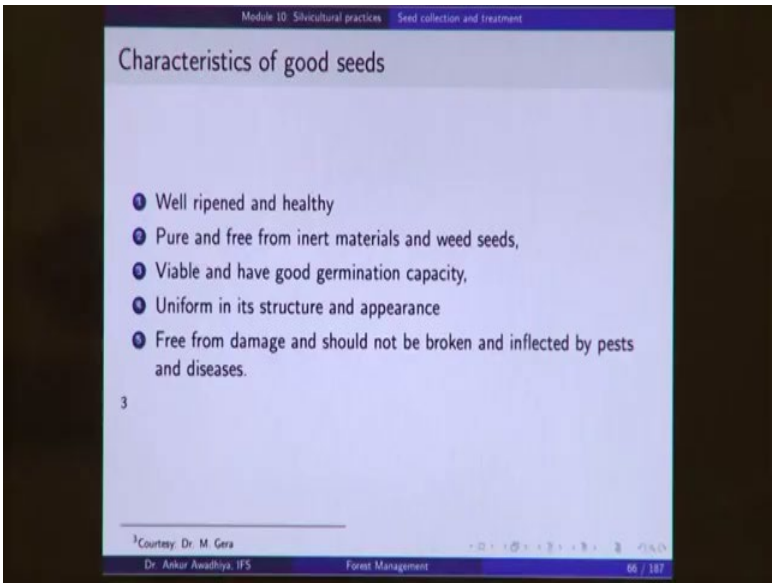

Now, when we talk about the use of seeds for Silvicultural practices, we require good seeds. And how do we define a good seed? A good seed is something that is well ripened and healthy. So, when a seed is being formed inside a fruit, then we need to wait till that stage that the seed has become well ripened, well mature, so that when you plant it in the ground, it should be able to germinate.

So, it has to be well ripened, it should be a healthy seed. It should not be a seed that is infested by say insects or is infested by some microorganisms typically, fungi. So, if you have seeds that have a that have fungi that are growing on top of them, those are not the kinds of seeds that we want for our silvicultural practices.

The seeds should be pure and free from inert materials and weed seeds. So, when you are doing a seed collection; and if these seeds are getting collected once they have fallen to the ground; so, in that case, you will also be having some amount of inert materials such as dirt or such as twigs or leaves. Also, there is a chance that other impurities such as other seeds also get inside.

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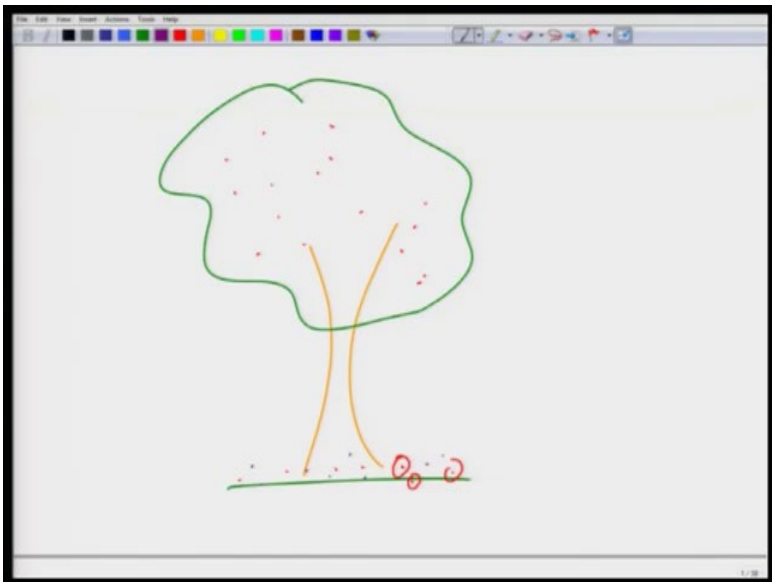

So, what we are talking about here is that, you have this tree and there are 2 options; either you collect the seeds when they are there on the tree itself, but then you have a chance that these seeds are not mature enough. So, they are not well ripened seeds. That is a choice that you need to make, or else you can collect seeds once they have fallen to the ground.

But when these seeds have fallen to the ground, when you are trying to collect them, there is a good chance that by the time you went there and collected these seeds; probably, some fungi have already started to act on these seeds. Probably, there are some insects that have started to bore holes into the seed coat. And, there is also a chance that when you are collecting these seeds then together with these seeds, you also collect some other seeds. Typically, those species that you do not want, or you also collect some dirt or some conkers or some twigs or some leaves that are also there on this ground.

But, when you want to use the seeds; when you will finally use them for the Silvicultural practices, then you will have to get rid of all these impurities. So, the good seeds are pure and free from inert materials and weed seeds. They are viable and have good germination capacity because we are using these seeds to grow plants and so, we want those seeds that are living seeds. If these seeds are already dead, then they will be non-viable; they will not give out the young plants.

So, they will be useless for the Silvicultural practices. They should be uniform in the structure and appearance.

So, typically what happens is, when you look at the seeds, the seeds of a plant may come in different sizes.

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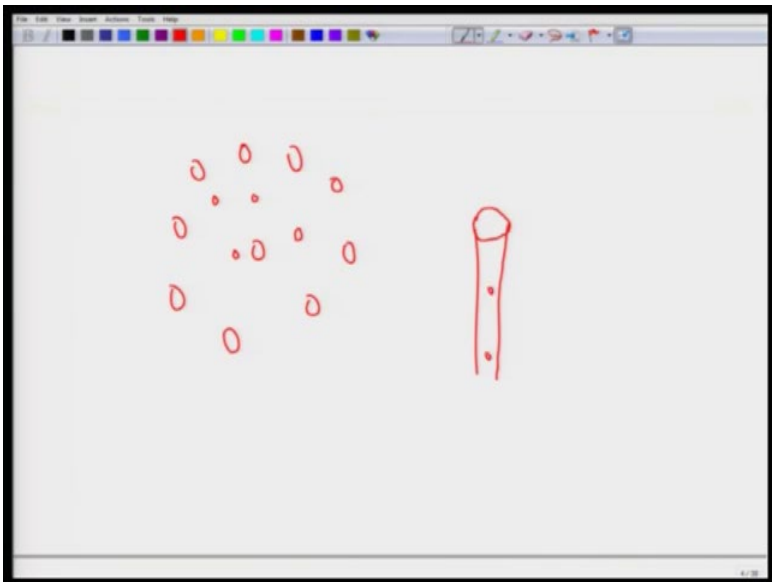

So just like all of us have different heights; we have different skin colors; we have different eye colors; we have different hair colors; similarly, the different seeds of the same plant or of the same species may have different appearances or may be having different sizes. Now, if you want to go for a mechanical usage of these seeds, when you want to put them into a machine that is sowing or that is doing some sorts of operations on these seeds, it is always preferred that all these seeds should be uniform.

So that, if you are say, using a pipe to dibble these seeds, and if you if there is a big seed, and there are some small seeds; so the small seeds will be able to get inside, but the larger size seeds will block your tube. So, it is always preferred that your seeds, when you are using them, they should be having the same appearances, the same size.

Next, they should be free from damage, and should not be broken, and infected by pests and diseases. So, they should be unbroken seeds. If your seeds have already broken apart; so, in that case, the endosperm is now exposed. Endosperm is food for the plants, but it is also food for a number of animals. So, once your seed coat has broken, then your

seeds are very easily available to be used as food by a number of organisms and so, there is a good chance that it will be very soon infected or infested by either pests, diseases or insects.

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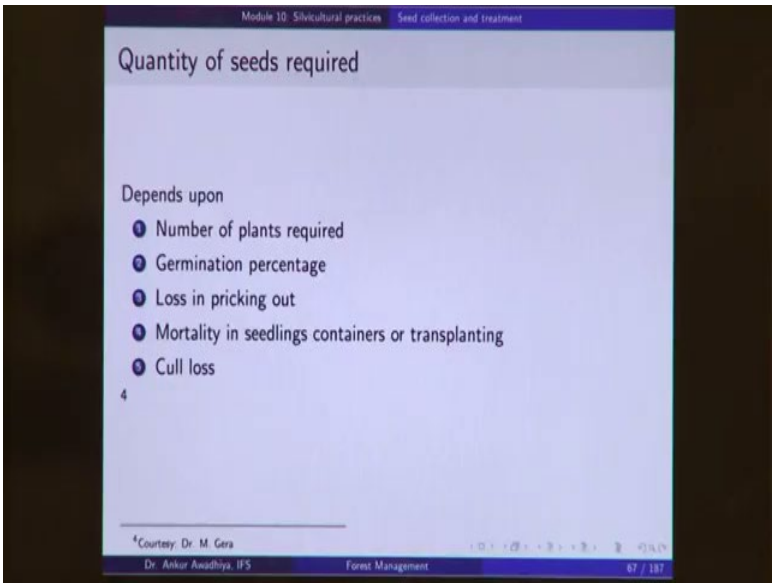

Now, how many seeds do we require? The quantity of seeds that are required for your Silvicultural operations; it depends on a number of things. The first one is the number of plants that are required.

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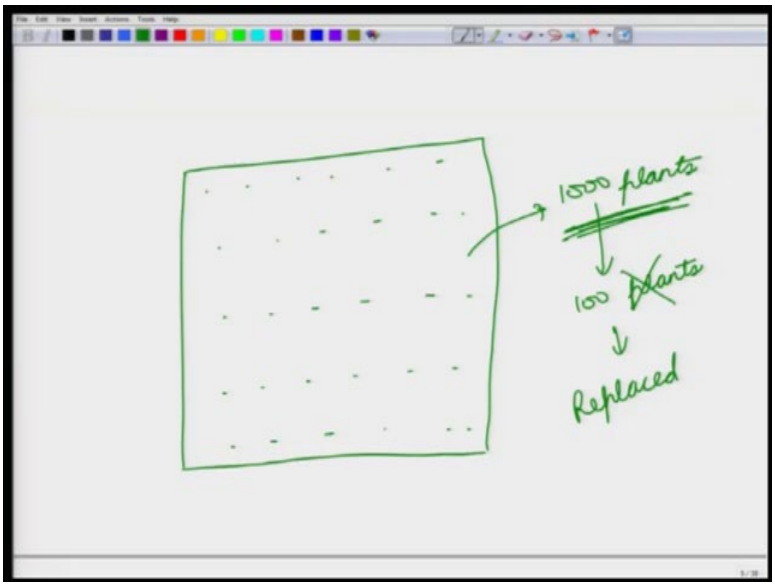

So, let us say that we are doing an artificial regeneration in this plot and suppose our plan is to have say 1000 plants. So, you want to have 1000 plants on this plot, and let us say that we are getting these plants from the seeds. So, how many seeds should you start with? Should you start with 1000 seeds? Should you start with 10,000 seeds? How do you get to this number?

Now, if you start with 1000 seeds and suppose only 80 percent of them are able to germinate; So, in that case, you will be having 800 plants that are germinating. So, 800 will be less than 1000, and in that case, you will be having a plant failure. On the other hand, if you start with a very large number of seeds, suppose you started with say 10,000 seeds and out of those 10,000 seeds, you got say, 8000 seeds; 8000 plants, but out of those 8000 plants you are only using 1000 plants.

So, in that case, your efforts will get wasted. So, you need to make a plan of how many seeds do you need for your Silvicultural operations. And, the number of seeds will depend on firstly, the number of plants that are required. So, when we talked about the Silvicultural management, we said that it begins with a planning stage.

Now, in the planning stage itself, you make an estimate of the number of plants that will be required. Now, these plants will not only include the plants that will actually be planted, but will also include some amount of replacement plants. Why? Because, when you are raising 1000 plants, so there is a good chance that after planting these plants, say 100 plants out of these, die-off.

Because they because before these plants were able to establish themselves, there was some climatic event because of which 100 plants died off. So, in the same planting season, you will have to replace these plants. So, these will have to be replaced which is known as casualty replacement. So, the number of plants that are required is this is equal to the number of plants that you will be planting plus casualty replacement and we typically take a figure of 10 to 15 percent of plants that will be replaced in the same planting season.

Now, the number of seeds will also depend on the germination percentage of the seeds.

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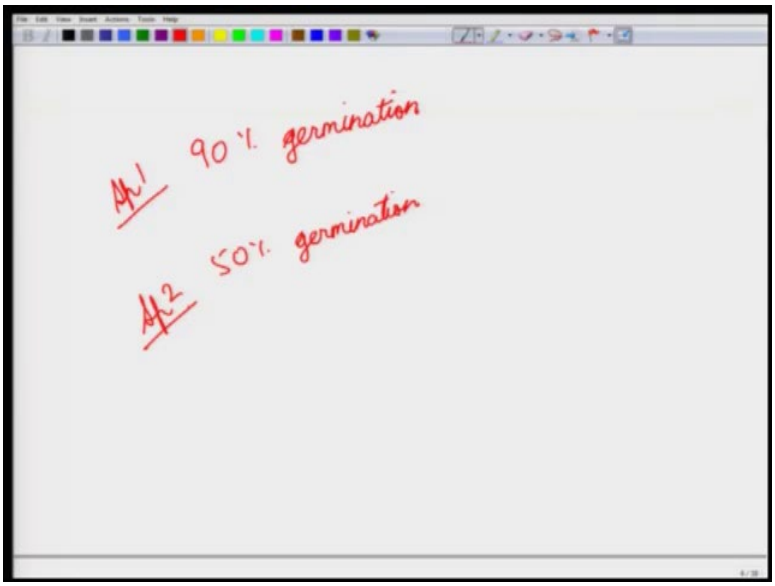

So, suppose there is a particular seed and it there is say 90 percent germination, whereas there is another species that shows only 50 percent germination. Now, it means that in the case of the first species, if you started with 1000 seeds, you will only get 900 seeds;900 plants that are germinating out of these seeds. But in the case of species 2, if you started with 1000 seeds, you will only get 500 plants that are germinating out of these seeds. So, if there is a species or if there is a lot of seeds that is showing a less germination percentage, then you should start with more number of seeds to get the same final result.

Then, it is also dependent on the loss in pricking out. Now what is pricking out? In the nurseries, germination and raising up of plants in poly pots, is done in 2 stages.

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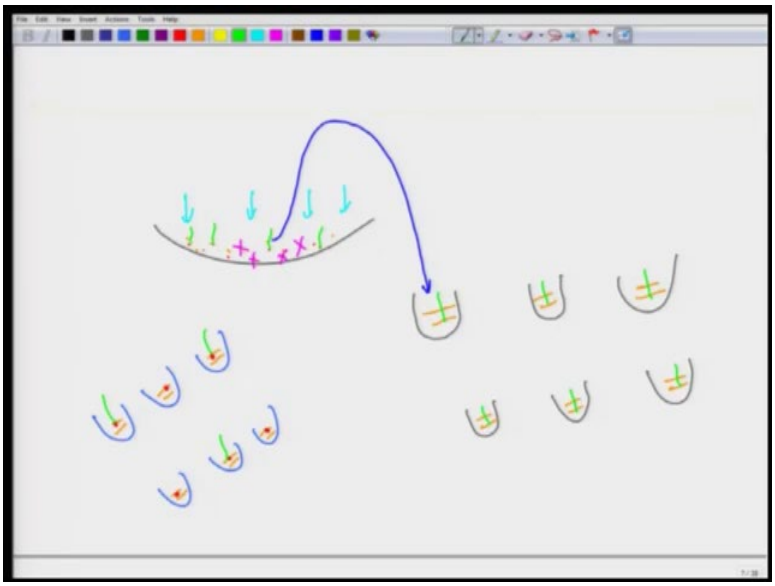

So, the first stage, we take sand we add seeds; we add water, and we let these seeds germinate into seedlings. So, there will be some seeds that germinate; there will be some others that do not germinate. Now, once you have these seeds that have germinated into seedlings, the next stage is to do a pricking out operation. Now, what do you do in a pricking out operation? Here you have poly pots which are essentially polythene bags that are filled up with the potting mixture. So now, you will take out these plants and you will put these plants in the poly pot.

Now, this is to ensure that in each and every poly pot you have got one plant. Now, as an alternative, in place of doing this pricking out operation, suppose you started with just these poly pots and in each of the poly pot, you added the potting mix and then you added the seed; and then out of these poly pots, only 3 seeds have germinated. So, in that case, your rest of the poly pots will remain empty.

So, to avoid that situation, we do the pricking out operation. So, in the pricking out operation, the germinated seedlings are taken out; they are pricked out of the sand, and then they are put again into a poly pot. Now, during this operation; during this pricking out operation, there is a possibility that while you are take while you are pricking out some plant, you applied too much of a of a force to this plant and this plant broke. So, those plants that get damaged during the pricking out operation; they also have to be considered when we are trying to compute the number of seeds to begin with.

So, the loss in pricking out also needs to be computed. Then, there will be mortality in seedling containers or transplanting.

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So, once you have so once you have done this pricking out operation; now, your seedlings are there in this poly pot, and now these seedlings are growing. But then, while these seedlings are growing into saplings, there is a possibility that some of these seedlings will die out in the nursery itself.

Probably, because a few of them got infested with some disease, or with some pests, or with some insects, or possibly because a few of them were not able to get sufficient amount of water, or any reason, or probably they were not able to get sufficient amount of sunlight, or because there was some genetic abnormality in that seedling. So, there is a chance that a few of these seedlings will also die out.

Now, when we are computing the number of seeds to begin with, we need to factor in the loss of plants during the poly pot stage, and also during later stages such as transplanting. Now, in the case of transplanting, you are taking these poly pots and then you are digging up a pit, and you are putting this plant inside. So, here you have this plant and the surrounding is filled up with soil. Now, during this operation again, there is a possibility that some of the plants will die out.

So, you are considering the mortality at each and every of these different stages. Then, you also need to consider the loss due to culling. Now, culling is a process in which you will deliberately want to get rid of a few plants. So, suppose, you have done the transplanting operation, but then you are saying that a few of the plants are odd man out and they are not growing at a fast rate.

So, in that case, you will want to replace a few of those plants even though they were living. So, you need to consider all of these different mortalities to compute the number of seeds to begin with.

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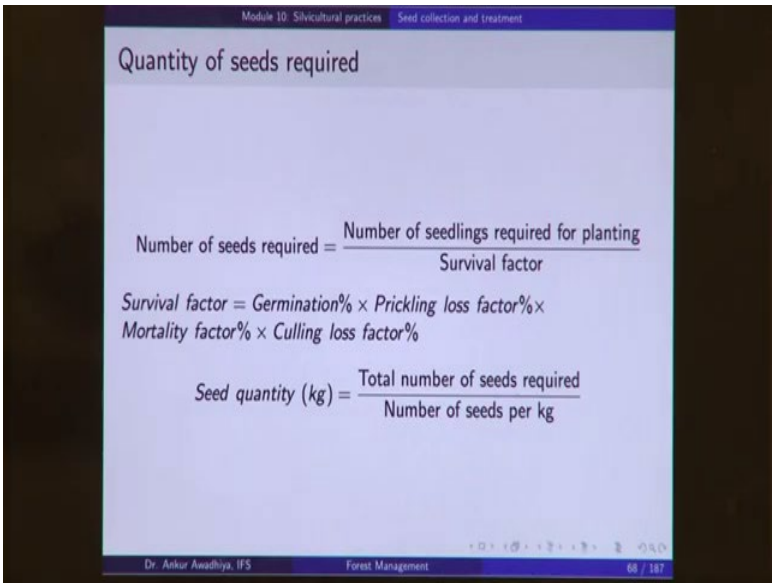

So, we can write it mathematically as the number of seeds that are required is the number of seedlings that is required for planting, including all of these including the number of plants that were to be planted in the first group, plus the replacement, divided by the survival factor. And, the survival factor is given as the germination percentage multiplied by the pricking loss factor multiplied by the mortality factor multiplied by the culling loss factor.

Now, when we say mortality factor; this mortality factor is not mortality, but it is, in fact, the number of plants that remain after the mortality.

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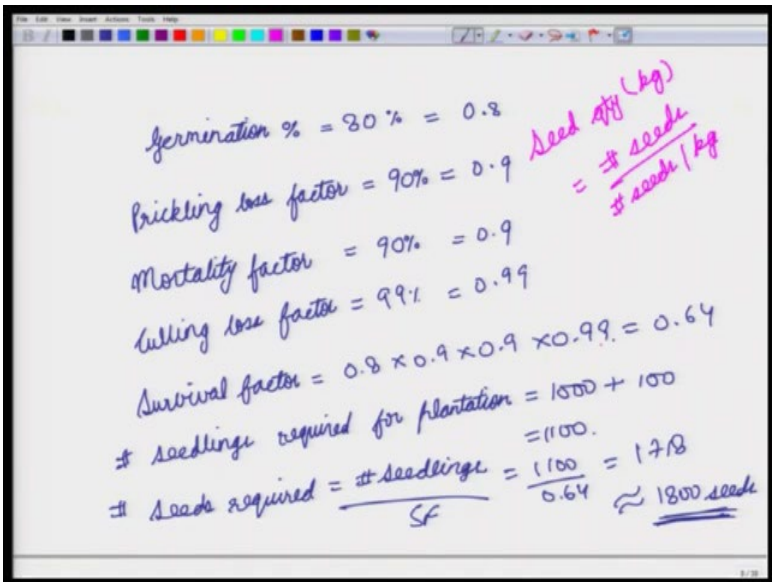

What we are saying here is that, suppose, the germination percentage is 80 percent, which means that, 80 out of every 100 seeds are going to germinate. So, then we will say that this germination factor or germination percentage is 80 percent or 0.8. Now, when we consider the pricking loss; suppose during the pricking operation out of 100 seedlings, 10 get damaged; so, in that case, 90 remain. So, the pricking loss is 10 percent, but the pricking loss factor is 90 percent, because 90 percent of them are surviving or 0.9.

Then, when we consider the mortality during the nursery stages, then there is a chance that say, we have you have only 10 percent mortality. So, 90 percent of the plants survive. So, the mortality factor, in this case, will again be given as 90 percent or a 0.9. Next, you have the culling loss factor. Now, the culling loss factor; suppose 1 percent of the plants are culled; so, the culling loss factor will be 99 percent or 0.99. And then, your survival factor will be given as 0.8 into 0.9 into 0.9 into 0.99 equals 0.64.

Now, the number of seedlings required for plantation is 1000 plus 100 which we include as the casualty replacement. So, this is 1100. So, the number of seeds required will be given as number of seedlings divided by the survival factor. So, this is 1100 divided by 0.64 is 1718 or approximately 1800 seeds. So, for our planting operation of 1000 plants, we should start with around 1800 seeds, so as to be able to get the requisite number of plants.

Now next, seed quantity is given as the total number of seeds that is required, divided by the number of seeds per kg, because we said that we require 1800 seeds. But then how, but then we cannot go and count each and every seed, because seeds typically are very small for a number of species. So, we do a computation as the seed quantity in kg is given by the number of seeds divided by the number of seeds per kg. And by that, we will get a figure as to how many kilograms or grams of seeds do we have to begin with.

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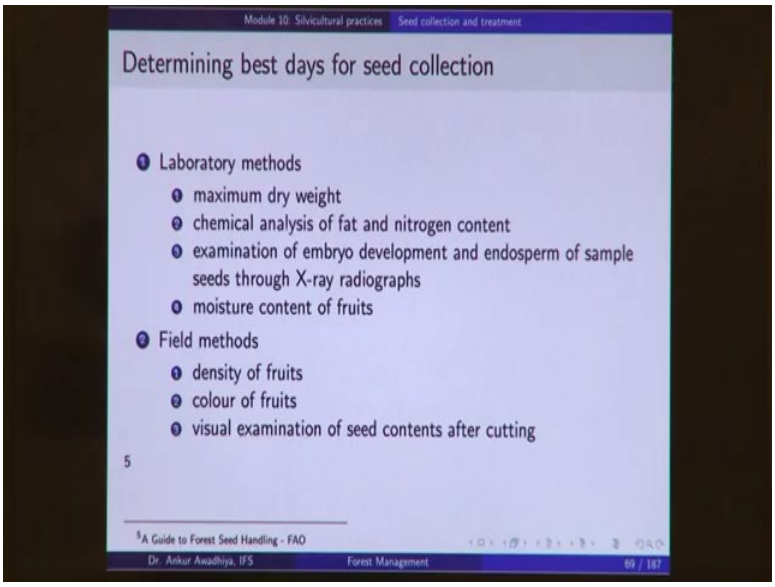

Now, when we are doing seed collection, there are a few things to be kept in mind. The first one is, when do you collect the seed? Now, we have seen before that for a number of species, we have different seed years.

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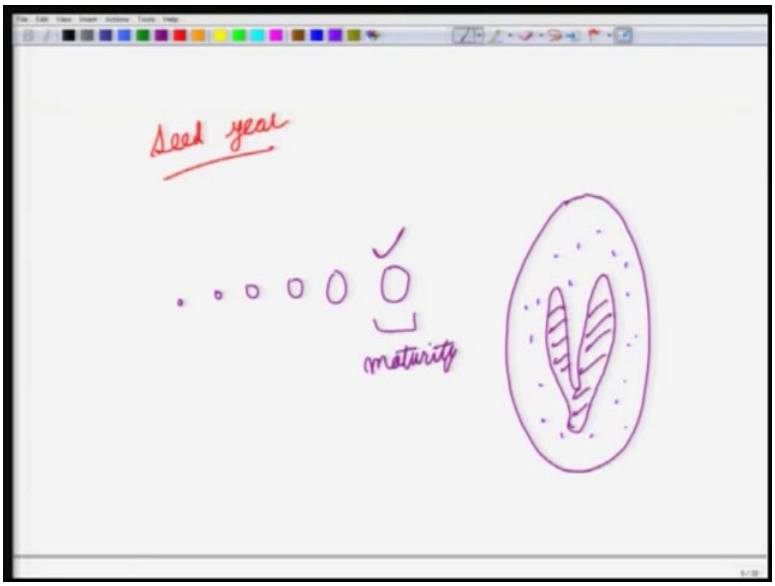

Now, what is a seed year? A seed year is that year in which the plants give out a large number of seeds. So, we typically do our seed collection during the seed years. But then in the seed years, which are the days on which you should go out and collect? Because you do not want to seed that is unripe, and at the same time, you do not want a seed that has fallen to the ground.

So, you want ripened seeds that are still there on the plants so that you can collect them without having a contamination of insects or dirt or twigs or whatever. So, how do you determine the best days for seed collection? So, there are 2 methods. The first one is laboratory method and the second one is the field method.

Now, in the case of the laboratory method, you can look at the maximum dry weight of the seeds. So, in this case, when you look at the growth of a seed; so, it will start from a small size and then typically it will reach a maximum size at maturity. So, in this laboratory method, what we do is; from the start of the seed collection season, every day or every few days, one staff will go, collect a few seeds, bring them out to the laboratory. And then, the lab technician there will do a dry weight measurement of these seeds

So, when the average dry weight has reached to this stage, it means that now the seeds are matured. And now, it is a good time to go and collect these seeds; so that is the first method. Second is chemical analysis of fat and nitrogen content. So, in this case, we

compute what is the fat and nitrogen content in a mature seed, and on every few days, the seeds are collected and their fat and nitrogen content are computed in the laboratory.

So, once it has reached to that stage where it is mature, then it is a good day to collect the seed. Examination of embryo development and endosperm of sample seeds through X-ray radiographs. So, in this case, what we do is; we take the seeds, we soak them in barium chloride solution. So, the barium chloride is able to reach inside the seed especially, in the non-living areas. And, in those areas where you have the living tissue, the barium chloride is excluded.

So, if you consider a seed, suppose this is the seed, and you have these cotyledons. So, the barium chloride will not be able to reach into the these areas. But the barium chloride will be able to reach into these areas. So, in that case, once your seeds have been soaked in this barium chloride solution, then you can take these seeds out do an X-ray scan of them and with that you will be able to see what is the size of your embryo.

So, if the size of the embryo is good enough; if you see that the size of the embryo is what it should reach at the time of maturity, then you will say that now the seeds are mature enough and it is a good time to collect them. Or, we can look at the moisture content of fruits. So, we can look at weight, we can look at moisture, we can look at fat and nitrogen content, or we can go with an X- ray radiogram.

Now, these are the laboratory methods. Then, we also have the field methods. So, in a number of cases, the field foresters do not have to resort to the laboratory methods, because you can get a very good idea just by looking at the tree or the fruit itself. So, one field method is the density of fruits, size of fruits and the density of fruits. So, once your fruit has reached an appreciable density, then it means that the seed development is now complete.

Or, you can look at the color of fruits. So, for a number of species, the fruits start as green in color and once they have matured, the color changes to say red or yellow or orange. So, if your fruits have now changed the color, it means that now these are completely developed and now the seeds can be collected. The good example is mango. So, if your mango has reached a yellow or orangish or reddish color, it means that now the seed inside is also mature enough and it can now be collected.

Or, we can do a visual examination of seed contents after cutting. So, in the case of those seeds that typically are larger in size, the field forester can just take a few sample seeds, cut them out in the field, and have a look inside what is the size of the cotyledons? What is the size of the embryo? If the size is good enough, it means that the seeds are now mature.

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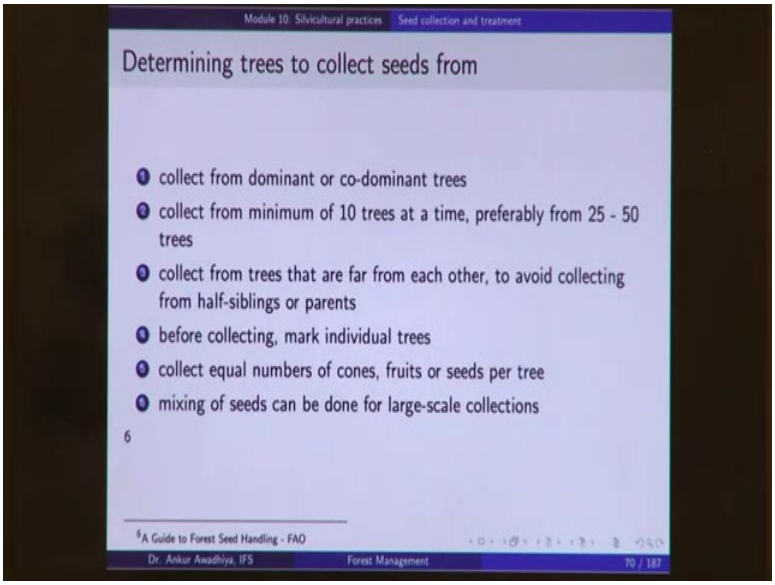

Now when we collect the seeds then we also need to determine not only which days we have to collect, but also which trees do we have to collect it from. So, the seed collection is done from dominant or co-dominant trees. Because these are typically the trees that are large in size because of which they are now exposed to the sunlight. And, at the same time, because they are exposed to the sunlight, so the plant is getting enough amount of nutrients which will in turn be diverted to the seeds.

So, here we can say that the seeds will get enough amount of nutrients because of which they will be much more viable as compared to a seed - as compared to a seed from a plant that is not a dominant plant, which is not getting enough amount of sunlight. Collect from a minimum of 10 trees at a time preferably from 25 to 50 trees. Now why is this so? Because, it there is a possibility that the seeds from 1 particular tree may not be that viable. So, we typically want to go for more number of trees.

Also, at a later stage, when these seeds are planted out in the field, if all of them are coming from the same tree; so, in that case, all of these plants that will grow will be

related to each other. And then, in the next generation, there will be a chance of inbreeding depression and so, you want to collect not just from ones from one tree, but from a number of trees typically from 10 to 50 trees.

Then, collect from trees that are far from each other to avoid collecting from half siblings or parents. So, this is very obvious. Before collecting, mark individual trees. So when you are doing the seed collection, you should first of all mark these trees so that at a later point of time, if somebody wants to cross-check, he or she should be able to cross-check what are the trees from which you had collected the seeds.

Collect equal number of cones, fruits or seeds per tree. So, it should not happen that that you are collecting from 50 trees, but from the first tree you collected say, 50 kgs and from the rest of the trees you just collected one kg. So, that should not be there; you should collect roughly equal number of seeds from each tree, so that the purpose is not defeated. Mixing of seeds can be done for large-scale collections.

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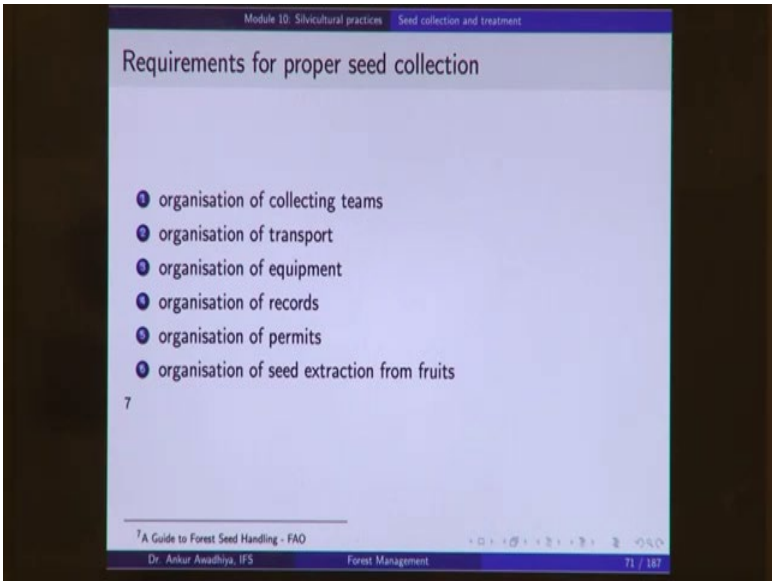

Now, what are the requirements for proper seed collection? How will you plan the operation? First of all, you have to organize the collecting teams. Who is going to collect these seeds? And are these people trained enough? So, for instance, the people who are collecting these seeds should know that the seeds have to be mature and the seeds have to be collected from the tree itself.

Now, if somebody is collecting say 50 kgs of seeds from the tree and mixes 1 kg of seeds that was collected from the ground. So, in that case, he or she will be mixing the pure seeds which are uncontaminated and are not having any infestation of say fungi or insects, and he or she is mixing 1 kg of seeds that were collected from the ground. So, such sort of things will then contaminate the whole lot of seeds.

So, in that case, the persons have to be trained and the organization of the collection teams includes the training of these collection teams. Next, you need to organize the transport of these seeds because and there are some seeds that do not have a very long viability. So, they have to be quickly moved to the next stage. So, the organization of transport is also very essential.

Then, organization of equipment. If you require say, poles or you require certain collection bags; so, they should also be made available to the people who are collecting. Then, organization of records; organization of permits. So, when you are moving the seeds from point A to point B, then you should be having sufficient paperwork, so that nobody is able to stop the movement of these seeds. Because if the movement is stopped, if the seeds are left in one place for a very long time, then the viability will suffer.

And organization of seed extraction from the fruits. So, when the fruits are collected and in certain state, in certain cases, the seeds have to be extracted very quickly. So, a good example is say, mango. So, if you have a mango fruit, the mango fruit is full of water. If you do not collect the seeds; if you do not do a depulping operation; if you do not wash and dry these seeds then in a short time this fruit will start to deteriorate and similarly, the viability of the seeds will also go down.

So, organization of the processing of the fruit has to be done in such a manner that it is a fast processing.

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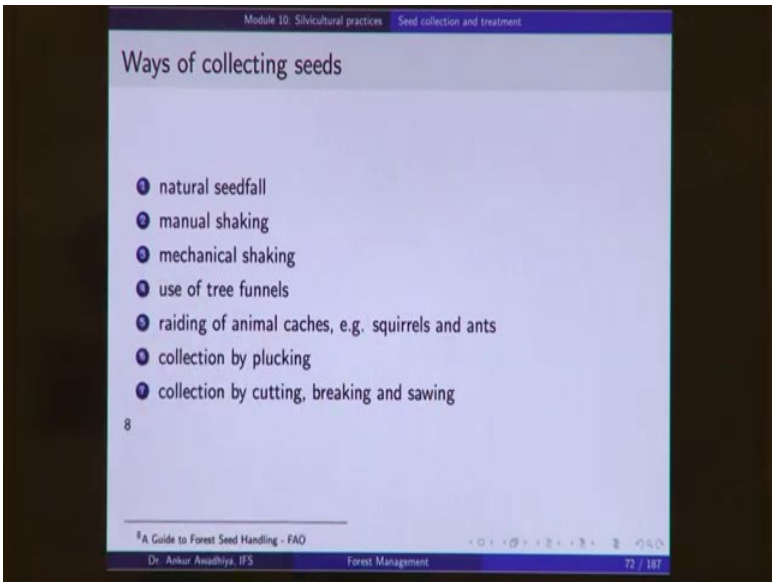

Now, how do we collect the seeds? Once you have done all this planning, how do you actually collect it in the field? So, there are a number of options.

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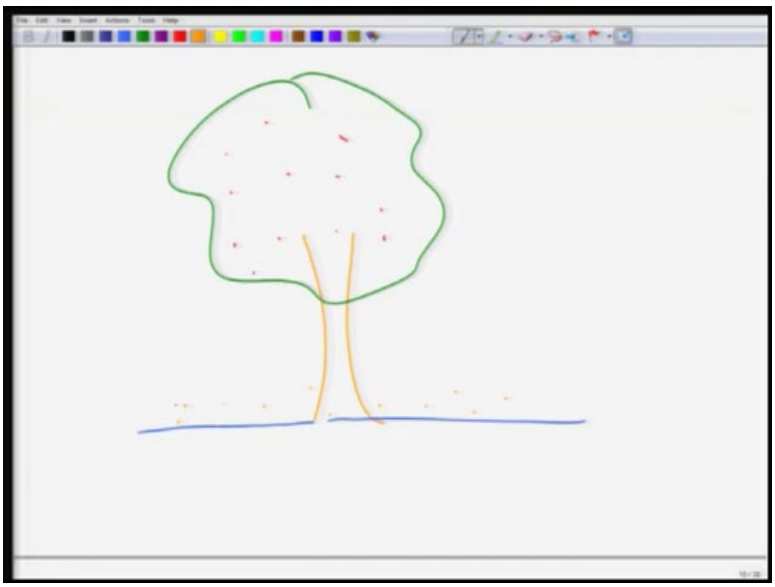

The first one is a natural seed fall. Now, in the case of a natural seed fall, what you will do is; here, you have a tree and naturally when the fruits are matured, they will drop down. So, what you will do is, you will put up a sheet around this tree and you the fruits will fall on this sheet. And say, every few hours you will you will depute your team so

that every few hours they go there and they collect all those fruits that have are that have fallen down.

So, this is collection using a natural seed fall. And, this is typically done in the case of those trees that are very tall or that are very strong. So, you are not able to shake those trees. The second option is manual shaking or mechanical shaking.

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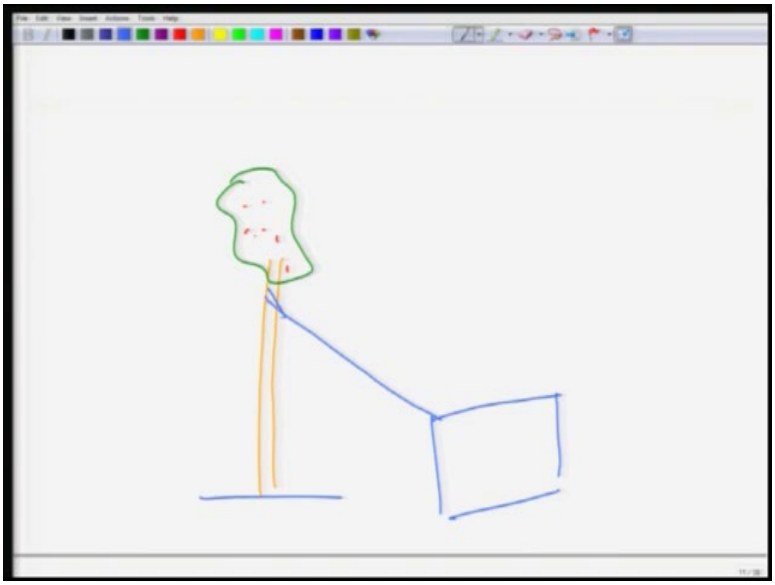

So, in this case what is done is, if this is typically done for those plants that are tall and thin. So, once you have decided you have determined that now it is a correct time, you will go there and you will hold this tree and you will manually shake it, so that any fruit that is now mature enough, it gets a motion and then it falls down. So, this shaking can be done either manually or with the use of some equipment.

So, there are mechanical shakers. They are they are mounted on a vehicle and then there is a rod that will go here it will hold this tree and it will shake this tree. So, you can make use of mechanical shakers. Another option is the use of tree funnels. Now, tree funnel is generally used for those trees that have very lightweight seeds.

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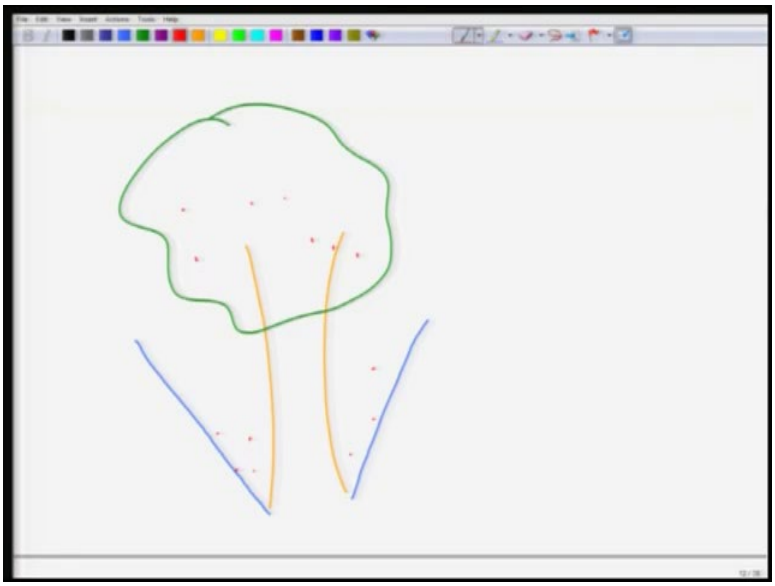

So, in this case, you will set up a funnel like this. Typically, this funnel is made out of cloth and so, the seeds that fall down are collected in in this funnel, and then they can be collected by the persons. In some cases, we also do raiding of animal caches such as those of squirrels and ants. Because, animals such as squirrels have a tendency to collect seeds into their hollows. So, you can make use of these hollows, and go and raid those hollows to collect the seeds.

But typically, this is this can be done in a research operation, but not for field workings. Or, we can do collection by plucking.

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So, in the case of collection by plucking, you have this tree. This tree is having these fruits and seeds that are now mature. So, you can ask a person to climb up the tree and pluck these fruits. So that is also an option, plucking of the fruits directly. Or collection by cutting, breaking and sawing. So, in this case, what is done is, you cut this tree; so, when you cut this tree, this tree will fall down; and once it has fallen down, you can collect these seeds.

Now typically, we do not cut trees to collect the seeds. But then, if there is a Silvicultural operation that needs to be done; so, if there is a tree that has been marked and is and it has to be felled, then typically the seeds that are there on the tree, if they are mature enough, then you can also collect those seeds.

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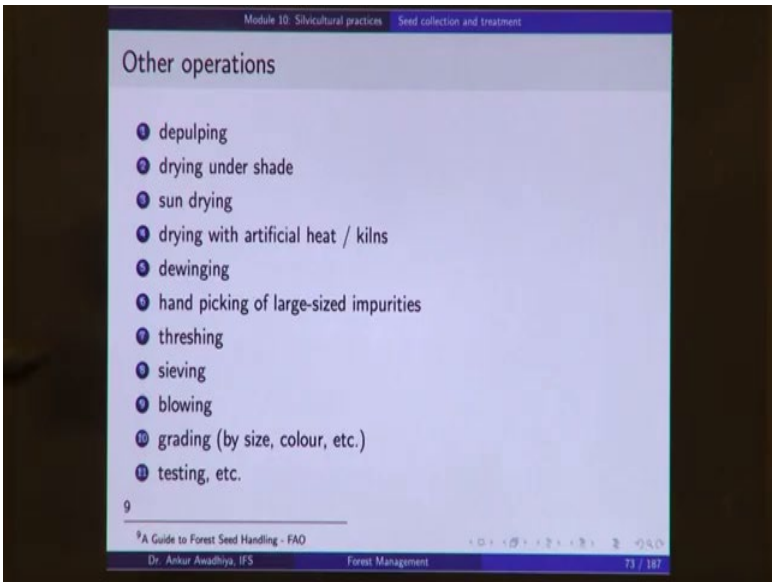

Now, once you have collected these seeds, then also we have to do a number of other operations such as depulping. Now, in the case of depulping operation, the pulp is removed; the seeds are washed. Now, this is done to reduce the total amount of moisture that is surrounding the seeds, and also to reduce the amount of food that is surrounding the seeds.

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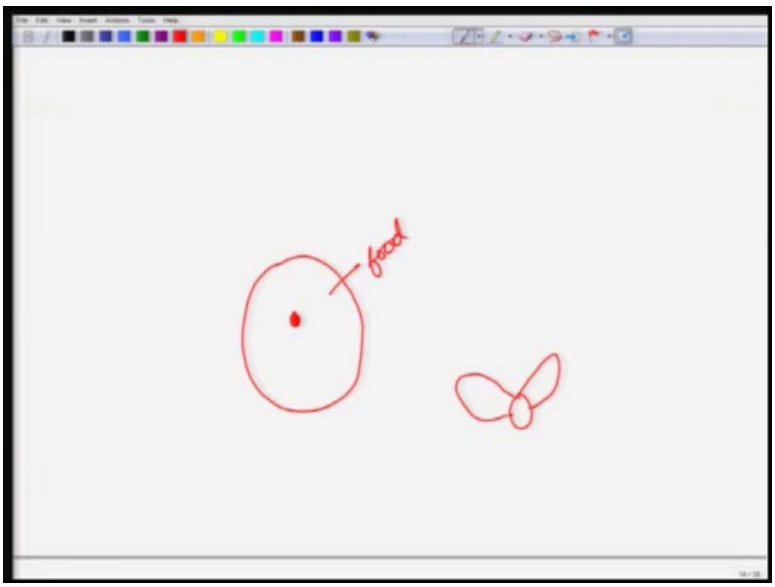

Because if you consider a seed that is surrounded by this fruit; so now, there is a very good incentive for animals or insects or pathogens to raid this seed and they will start to

eat up the food material that is surrounding the seed; but then, this will this may also impact the seed itself. So ,you want to get rid of this food material as soon as possible. So, there is this depulping operation that is done in which the pulp is removed. Now after you have gotten your seeds, next stage is to dry them.

Now, this drying can be done under shade or exposed to the sun or done in an artificial kiln or a dryer machine. Depending on the species; depending on the seeds, you can go with one or more of these options. So, for those seeds that get damaged by exposure to direct sunlight, you will go with drying under shade or drying in an artificial kiln. But, for those seeds that need to be dried very quickly, will not make use of schedule; either directly dry them in the sun, or you will dry them in a kiln. So, the next operation is drying. So, you have depulped the seeds; you have dried the seeds.

Next, we go for a dewinging operation. Now, a dewinging operation is done for those seeds that have wings. So, you have the seed and then there is a wing that is attached to it.

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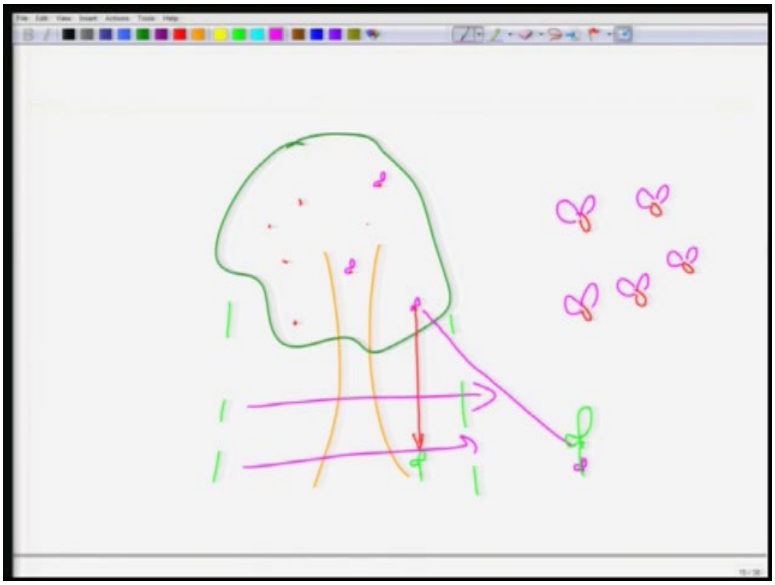

Now, why would certain seeds have wings? Because if you consider a plant, so here you have this tree and you have the seeds. Now, if you have a species that does not have the wings, then the seeds directly fall down to the ground. In which case, this the new plant that will grow up will be growing in the shade of the mother plant.

Now to avoid this possibility, for certain species, we have winged seeds. Now a winged seed when it is exposed to air, the wings will make use of the air and suppose this is the wind direction, so this seed will fall down here. And in that case, the plant will come up at a distance from the mother tree. Now, this wing is a is a structure that has evolved through evolution.

But then, when you are doing the your Silvicultural operations; when you are doing Silvicultural practices; when you are raising the seeds in a nursery bed; then you do not need these wings. So, in that case, these wings will be removed. So, once you have collected these seeds, and these seeds have these wings; so, these wings will be removed either by cutting or by breaking. So that is the dewinging operation. It is only applicable for a certain number of species.

Next operation is hand picking of large-sized impurities. Now, these impurities could be things like twigs or leaves or say seeds of some other plant or probably some pebbles. So, if they have come up along with the seeds, then you need to get rid of them. Next is the threshing operation. Now, in the threshing operation, you separate the heavy portion from the lighter portions.

So typically, in this case, the heavy portion is your seed and the lighter portions are the smaller impurities. Now, next you can make use of sieving and blowing operations. Now, in the case of a sieve, a sieve is a mesh like structure.

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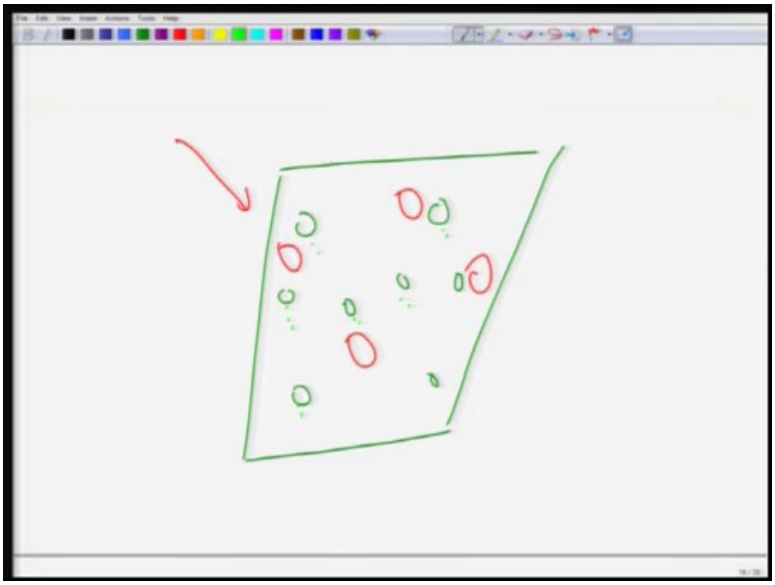

So, you can have a mesh with these holes. And, this mesh or this sieve is shaken and the seeds are dropped on 1 side. So, the larger-sized seeds will move past this mesh, but the smaller size impurities will go down from the holes. So, this is a sieving operation. Or you can make use of a blowing operation

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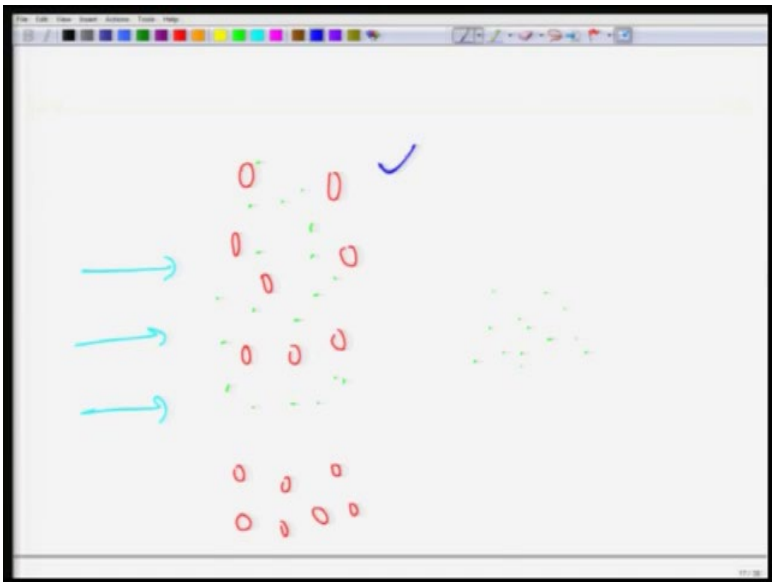

Now, in the case of a blowing operation, the seeds together with the impurities fall down with gravity, and you have a fan that is blowing air. Now, because in this case, the fan will blow-off these impurities, whereas the seeds will fall down, and you will have a purer collection of seeds. So, this is the next operation.

This is followed by grading operation. So, in the grading operation, the seeds are graded based on their size; based on their color; or based on certain other criteria such as the appearance of the seed coat. So, you will you will want to have seeds that are very similar in appearance that are very similar in size, shape, weight and their coat as a single lot. And, this is known as the grading operation.

Another operation is that of testing. So, in the case of testing, once you have graded these seeds, once you have collect; you have made these lots, next you want to know what is the germination percentage? What is the viability of these seeds? So that will be done in the testing operation.

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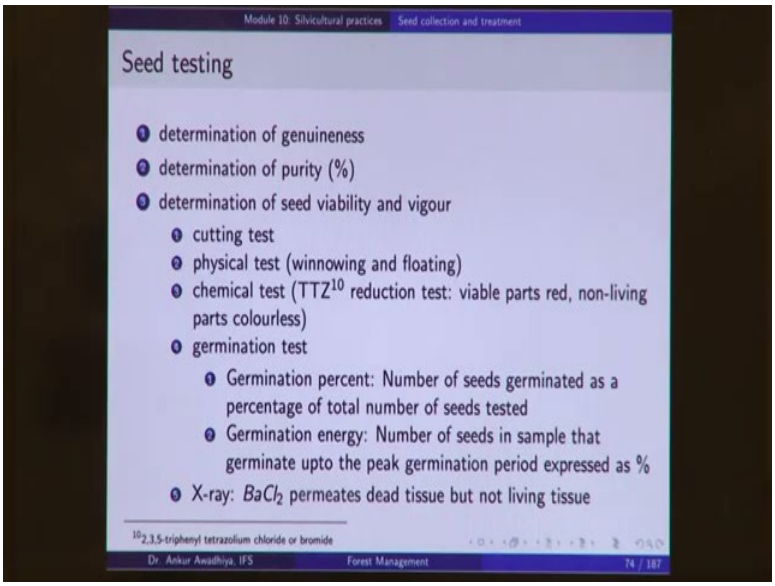

So, you will have all these different operations that are done. In the case of seed testing, typically we want to know these criteria. What is the genuineness of these seeds? So, if I get a packet and this packet says that these are seeds of a particular bamboo variety such as a *Dendrocalamus strictus*. But then, there is a possibility that the seller was selling these seeds in place of *Dendrocalamus strictus* has given me some other species bamboo seeds such as say *Bambusa bambos*.

So, during the testing phase, we want to know, if all these seeds are actually *Dendrocalamus strictus* or whether they belong to some other species. So, the seed testing you want to know, what is the genuineness of these seeds? What is the level of purity in these seeds? Purity means whether you have these seeds as pure seeds or whether there are certain impurities. Do you have certain amount of say, dust that is added to these seeds? Just to increase its weight.

Or, whether you have some fragments of leaves and twigs that are left with these seeds? What is the level of purity? Then, you also want to know what is the level of seed viability and vigour? Now, seed viability and vigour are checked using cutting test. Now, in the case of a cutting test, you cut the seeds and look at the development of the embryo inside this seed. Is the embryo mature enough? If it is mature, then there will be a good viability. If it is an immature embryo or if the embryo itself is missing in most of the seeds, then it will tell us that these seeds are non-viable.

Or, we can make use of things like physical tests such as winnowing and floating. Now, in the case of winnowing, it is a very similar operation to the blowing operation. So, in the case of winnowing, you want to know what is the density of these seeds? Whether these seeds are having holes inside, cavities inside, because probably insects have infested these seeds; so, they have bored holes inside; they have made cavities inside, and so, now these seeds are very light in weight, they have a lesser density.

Now, because these seeds have already been infested, so they will not be able to grow. They will be non-viable or the viability will be less. So, how do you know whether your seeds have cavities inside or not? So, a good option is to do winnowing. In the case of winnowing again, you take you drop these seeds.

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So, they are falling down because of gravity, and you blow air to it, and in this case, the smaller size seeds will fall at a distance, the larger size seeds will come here. So, you can look at the percentage of seeds that are lighter or that are having lesser density; so, that will give you an indication of those seeds that are having cavities inside or you can make use of a flotation test.

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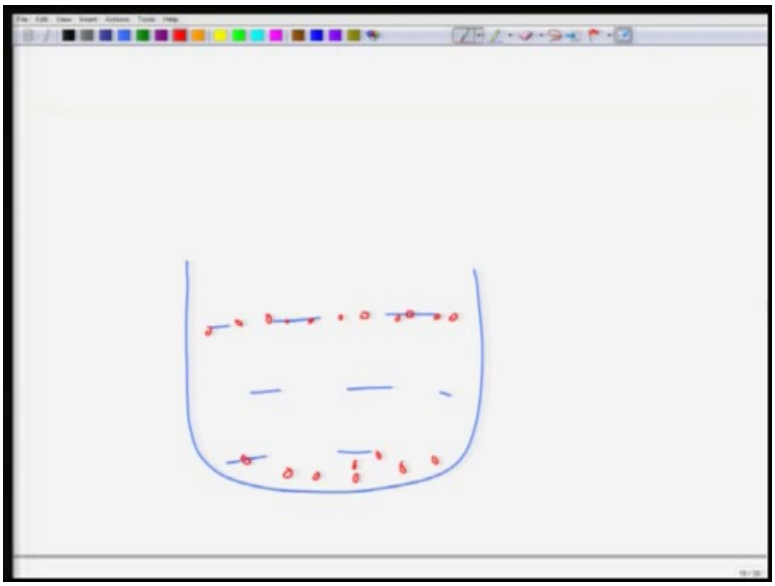

Now, in the case of a flotation test, you take a container with water, you add the seeds, so there will be some seeds that float on the top and there will be some seeds that staying down to the bottom. Now, those seeds that are floating on the top are having air cavities probably because they have been infested. So, you can make use of these physical tests to get an idea of the amount of viability of these seeds.

Or, you can make use of chemical tests such as the TTZ test. Now TTZ is 2,3,5-triphenyl tetrazolium chloride or bromide. Now, this is a chemical which is reduced by those tissues that are living. So you take a you take your seeds; you cut them; you soak them in the TTZ solution, and those portions that are living will be stained red in color, because they have reduced it to a red colored dye and those portions that are non-living will be colorless.

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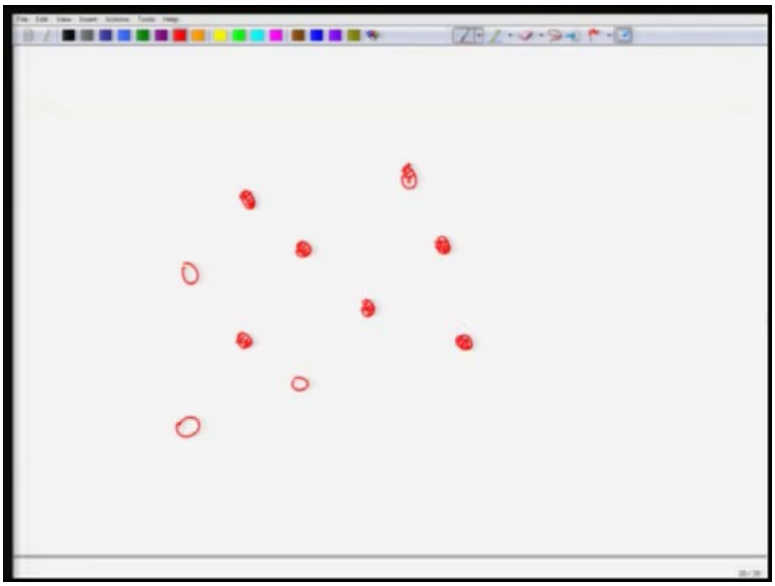

So, suppose you took 10 seeds so, we began with we began with 10 seeds. And, out of these 10 seeds we are seeing a red color and say, 7 of them. It will tell us that 7 out of these 10 seeds are viable the rest 3 are non-viable. So, this is a chemical test of viability. Or, we can make use of germination test. Now, in the case of a germination test, the seeds are actually germinated.

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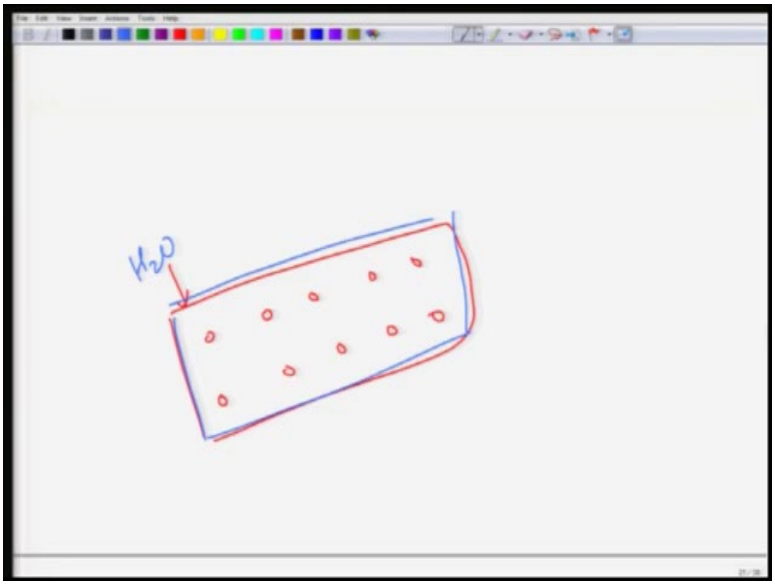

So, you take a tissue paper;you add these 10 seeds; you add water to it; you cover it with another sheet of tissue paper, and you leave it for say 2 days. Now, this number of days

will depend on the species to which these sheets belong. Now suppose, there is a species generally germinate germinates in 2 days. So, you had added these 10 seeds; you allow them to germinate and then after a while you see that only 6 plants have germinated out.

So, germination test is also an actual test that can give you the amount of viability in these seeds. Now, why do we have all these different methods? Because germination is possible, but is difficult in certain species. So, there are certain seeds that will take a very long period to germinate. So, in that case, it is much faster to take to make use of say the chemical test the TTZ test, because it will give you a result in a few hours whereas, in the case of actual germination, it might take even say a few weeks for certain species.

Now, when we are doing the germination test, we compute 2 parameters. The first one is the germination percent which is the number of seeds that are germinated as a percentage of the total number of seeds that were tested. So, out of 10 seeds if 6 germinated, it means that the germination percentage is 60 percent. The next thing is the germination energy or the number of seeds in the sample that germinate up to the peak germination period expressed as percentage.

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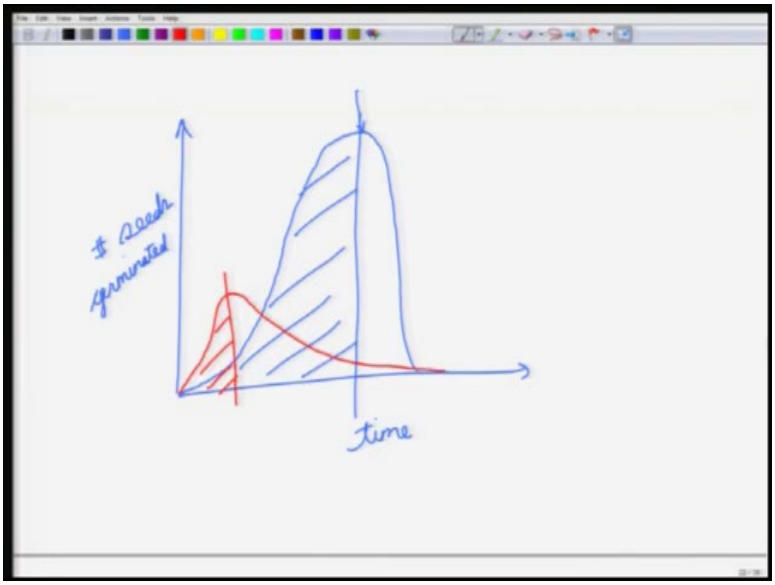

Now, what this is talking about is that if you plot the number of seeds germinated versus time. So, in the beginning, very few number of seeds will germinate, then the number of seeds that are germinating will increase. It will reach a maxima and then it will come

down. So, till this maxima point, what is the percentage that is there on the left side of this curve will give you the germination energy.

Now, till the maxima time, if more and more number of seeds have germinated, it means that they have a large amount of vigour, which means that they will germinate very fast, when they are actually used in the Silvicultural purposes. Whereas, if you get a curve something like this, so it increased and then you get a very long tail; so, this is the maxima.

So, in this case, the germination energy is less because the seeds take a very long period to germinate out. Another test is the use of X-ray. So, in this case, you soak your seeds in water for a few hours, then you soak them in a barium chloride solution. Barium chloride will enter into the dead parts, but will be unable to enter into the living parts. And thenn you expose these seeds to X-ray.

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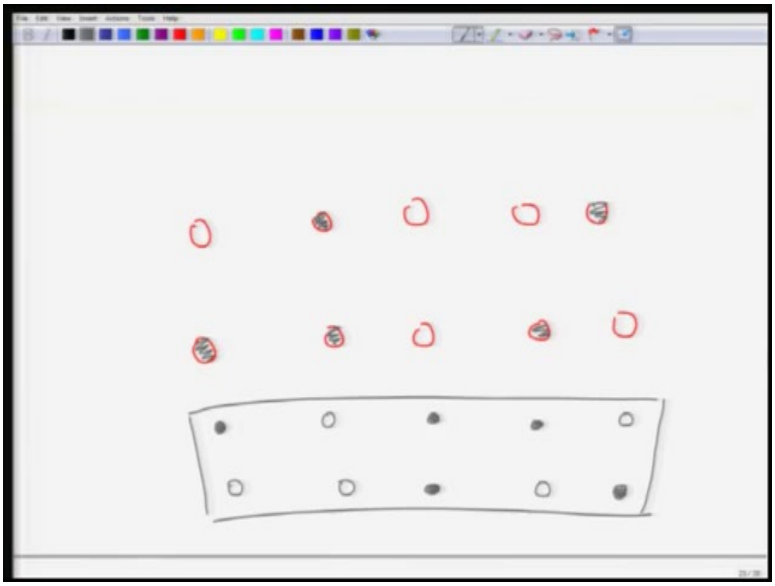

So, suppose we started with these 10 seeds, and we find that barium chloride was able to enter say 5 of these. Now, how do you know that barium chloride was able to enter? Because X-rays will not be able to pass through these seeds. So, when you look at the film of X-ray, X-ray was able to pass through this first seed so it will look dark in color. This will look white in color, again, dark, again dark, this will look white, this is white, white, dark, white and dark.

So, anything that is dark on the film where the film was getting exposed, it means that the X-rays were able to pass through the seeds which means that those seeds were living. But wherever you get a white spot, it means that the X-rays were not able to pass through the seed because barium chloride was able to enter inside. And, because barium chloride was able to enter inside, it means that those seeds for non-living seeds.

So, in this case, we can see that there is a 50 percent viability in these seeds. So, we can make use of all these or even some other parameters to do or testing to determine the seed viability and vigour.

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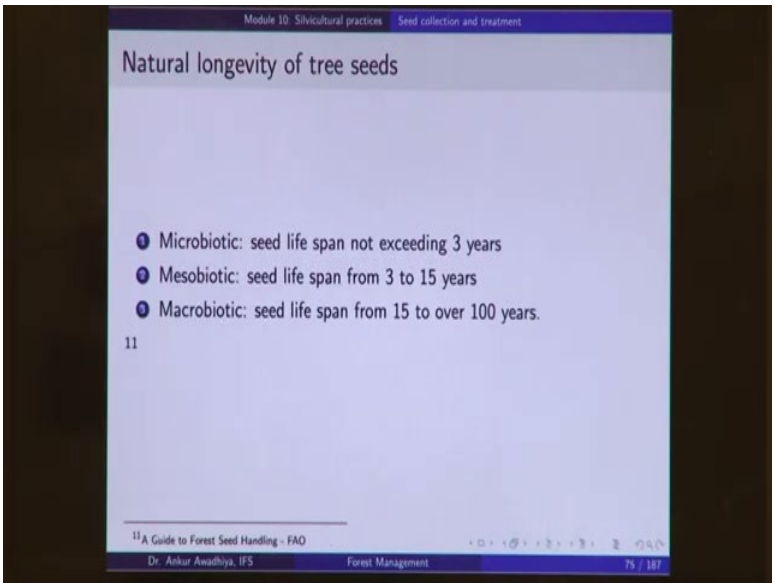

Now, once you have collected these seeds, you have to store these seeds. Because typically, you will not be using all of these seeds together. So, while storing we need to be sure about the natural longevity of these tree seeds. There are certain species that have microbiotic seeds, which means that the seeds have a short life span. Some are mesobiotic, which have a middle life span. And, some are macrobiotic with a very long life span.

So, those seeds that are macrobiotic can be stored for very long periods of time, whereas those seeds that are microbiotic can be stored for a very short period of time.

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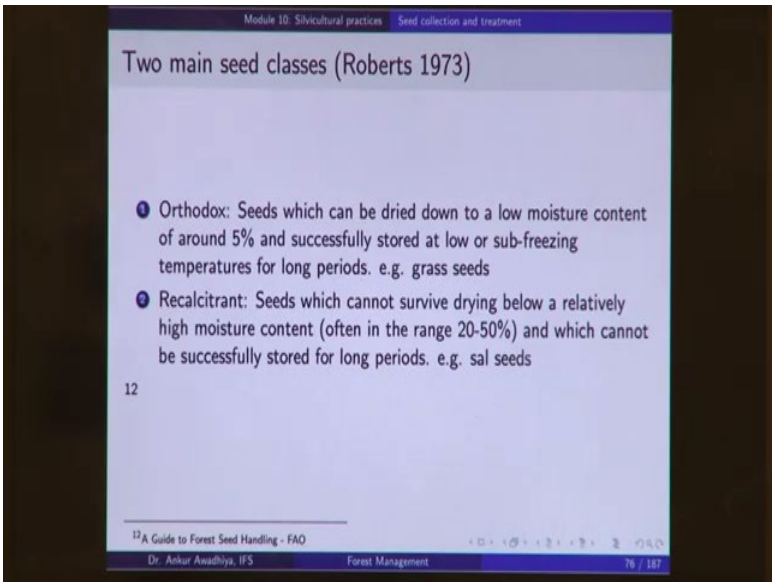

And, based on this, we classify seeds into two categories - orthodox seeds and recalcitrant seeds. Orthodox seeds are those seeds which can be dried down to a low moisture content of around 5 percent successfully stored at low or sub-freezing temperatures for very long periods, such as grass seeds. Whereas, recalcitrant seeds are those seeds that cannot survive drying below a relatively high moisture content, and they cannot be stored for long periods of time, such as the sal seeds.

So, while storing, you need to know whether your species is an orthodox species or it or a recalcitrant species. If it is an orthodox species, you can dry it out and you can store it for a very long period of time.

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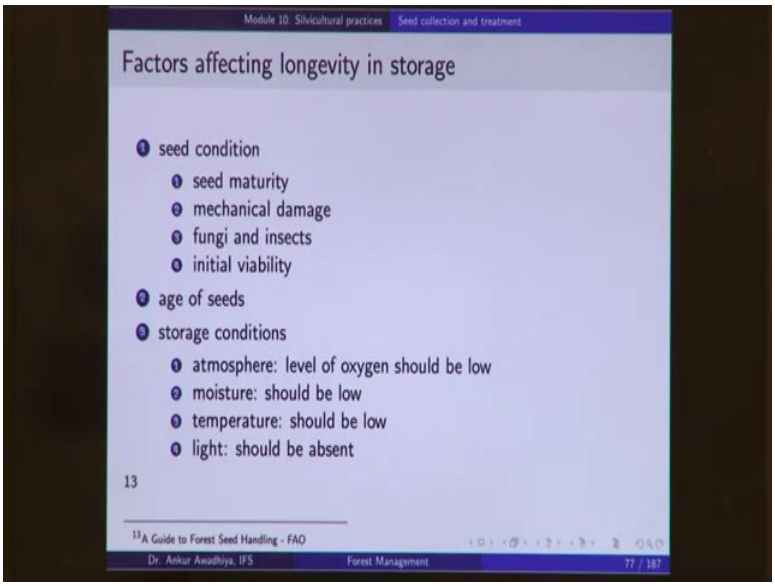

Now, while storage, the longevity goes down with time, and it will go down depending on several factors. The first one is the condition of the seeds; were the seeds mature when you are putting them for storage? were the seeds damaged? If they were damaged, then they will lose their viability in no time. Whether, there were fungi or insects? How much was the initial viability?

If you start with a high initial viability, then you will end up with a substantially large initial - substantially large viability. But, if your seeds themselves were having very low viability to begin with, then during storage, the viability will go down further. And, finally, you will be having seeds which are non-viable.

Then, age of the seeds and the storage conditions. What is the atmosphere where the seeds are being stored? Primarily, the level of oxygen when you are storing these seeds. You should store them in low oxygen environments; you should store them in low temperature environments; in low moisture environments, and in low light environments. So typically, we store seeds in bins that are airtight and we store them in those areas that are that are dry and that are having low temperatures.

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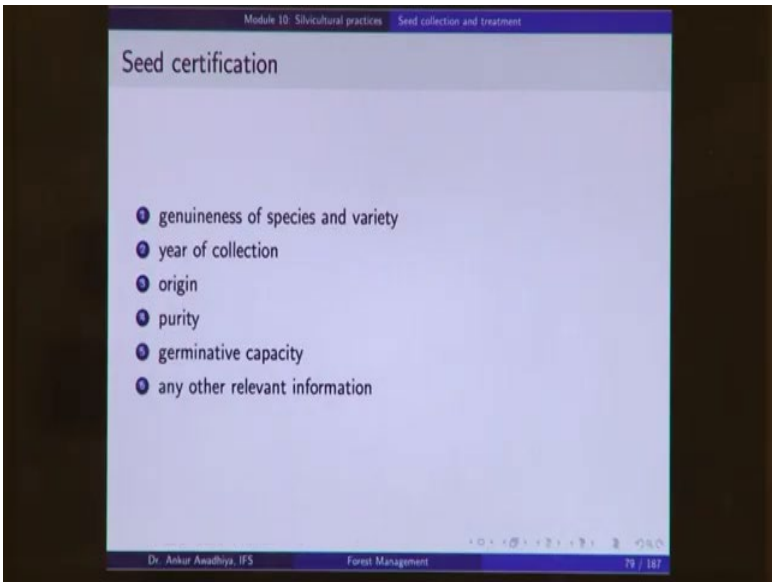

Now, after storage, we also need to know about seed certification. So, a seed certificate gives you information about the genuineness of the species, and the variety, the year of collection, the origin or the provenance of these seeds; so whether your seeds were collected from say Uttar Pradesh or whether they were collected from say Tamil Nadu.

Because, these plants will be having certain local differences in their appearance and in their phenotypes. So, you need to know about the origin of these seeds; you need to know about the purity of the seeds; the germinative capacity and any other relevant information. So, a seed certification typically is done by a third-party agency which gives a certificate that gives you all this different information.

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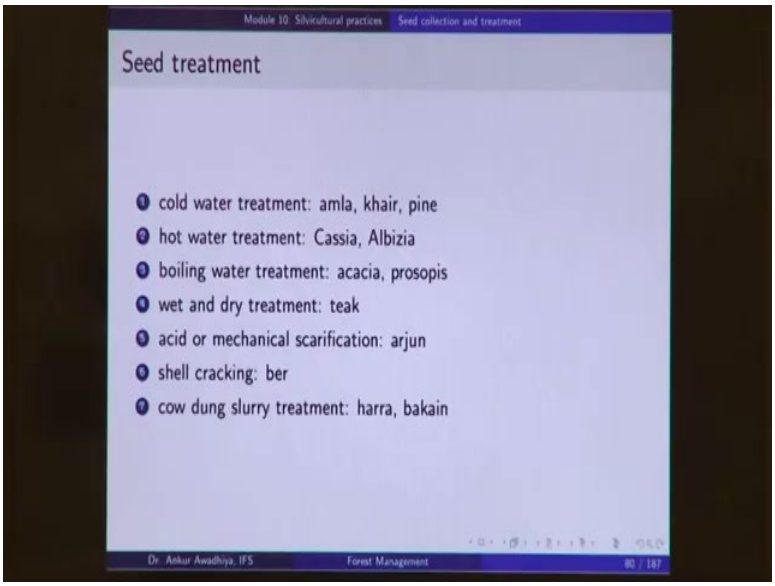

Now, once you have collected these seeds, you have processed these seeds; you have stored these seeds. Now, you want to germinate these seeds for use in a nursery. Now, in a number of cases, before germination the seeds have to be provided with certain other treatments to increase their level of germination. Now why are these treatments done? This is done typically because the seeds have a very hard outer seed coat.

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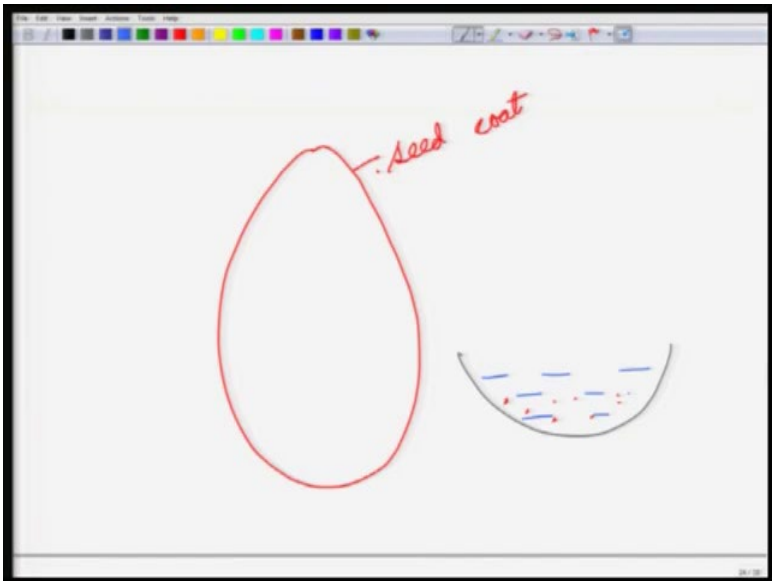

And, this seed coat, in certain instances, it prevents the embryo from getting out. So, you need to break this seed coat or you need to make it its soft, so that the embryo is easily

able to break it itself and come out. So, what are the seed treatments that we generally provide to the seeds? The first one is a cold-water treatment. Now, in a cold-water treatment, you take water at room temperature, dip your seeds inside soak them for a few hours, and then you will use them in the nursery.

Another is a hot water treatment. So, in a hot water treatment, you add water at a higher temperature. So cold water treatment is generally used for the species like amla, khair, and pine. Hot water treatment is required for Cassia and Albizia species. Boiling water treatment. Now, in the case of a boiling water treatment, you take a container, put seeds, add boiling water, and then let these seeds remain in this water till it cools down to the room temperature.

So, a boiling water treatment will typically be required for those species where the seed coat is very hard. Then, you may you may require a wet and dry treatment. Now, in a wet and dry treatment, you soak these seeds, then you dry them out in the sun, then you soak them again, then you dry them again. So, by doing this process again and again, you are softening or breaking up the seed coat. It is typically required for teak.

For certain other species, you require acids scarification or mechanical scarification. In which case, you use acids or you use mechanical abrasives to break open the seed coat. This is typically required for species like arjun. In certain other cases, you require a shell cracking. Now, in the case of a shell cracking, the your laborer will be using an equipment to crack open the shell. Now, this is used for those species where the coat is very hard such as ber.

And, for certain other species, such as harra and bakain, you go with a cow dung slurry treatment. In which case, you bury these seeds along with cow dung so that enzymes and insects are able to eat away the seed coat, and then you will be able to use these seeds. So, these are the different kinds of seed treatments that are required.

So, in this lecture, we looked at what a seed is? how do you collect a seed? When do you collect a seed? From which trees do you collect a seed? How do you collect a seed? How do you ensure that your seed is good? What are the characteristics of good seeds? How do you test these seeds? How do you do a viability assessment, germination assessment? And finally, how do you store these seeds? And, how do you use these seeds? And what

are the kinds of seed treatments that at times are required before using these seeds? So that is all for today.

Thank you for your attention [FL].