Forest Biometry
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Lecture - 26
Basal area of a tree and strand

[FL]. In this week we shall begin a new topic that is the Basal Area of a Tree and Stand.

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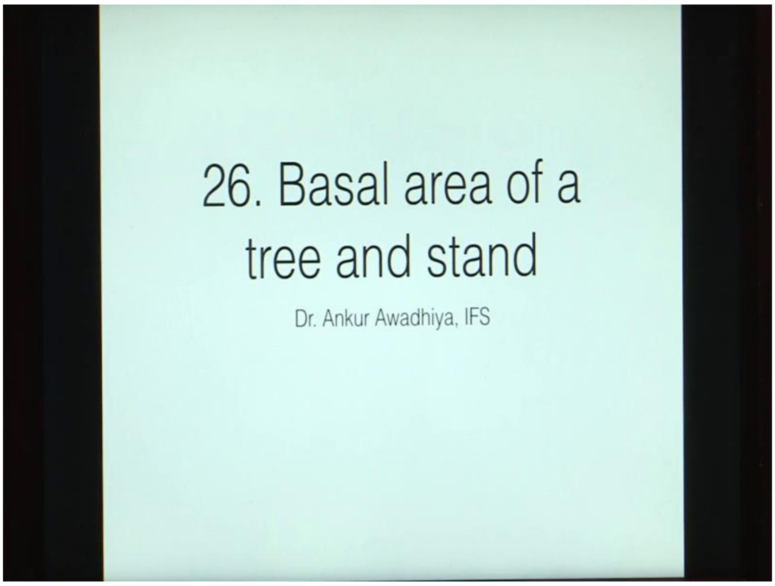

So, what do we mean by basal area?

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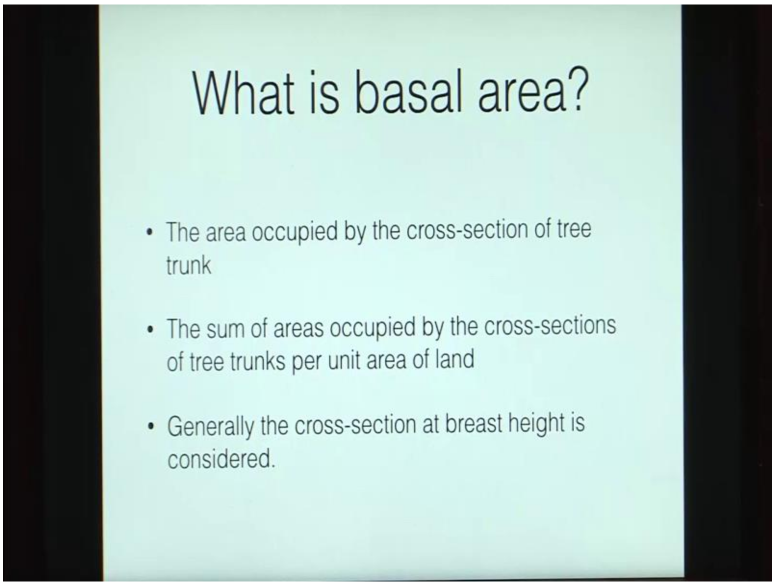

The basal area is the area occupied by the cross section of a tree trunk. That is if we drew a tree, if this is a tree and if we took any cross sections.

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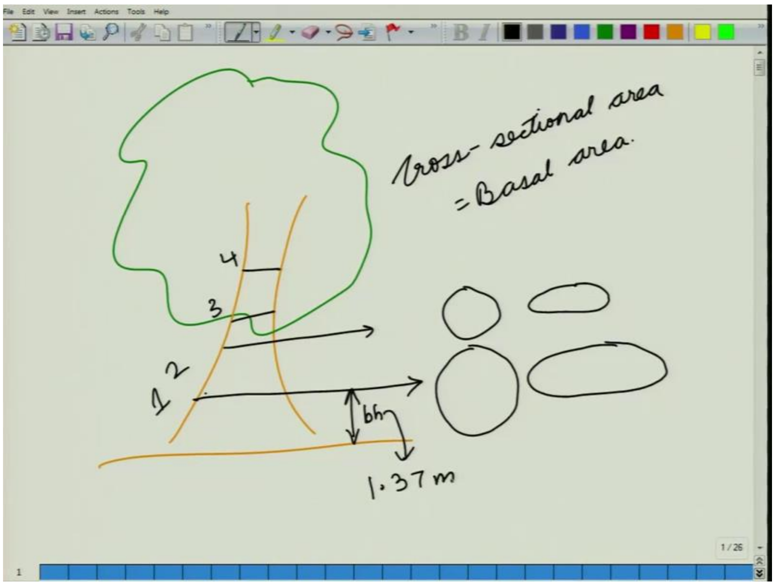

So, suppose we take a cross section here that will look maybe as the circle or may be it could be elliptical or some at regular shape. Or we it could take a cross section here, which should be a smaller circle or a smaller ellipse or a smaller irregular shape. So, these cross sectional areas is known as basal area.

Now, coming back to the slide. So, the area occupied by the cross section of a tree trunk is the basal area. The sum of areas occupied by the cross sections of the tree trunks per unit of land is called the basal area of a stand.

So, essentially if we had a number of trees.

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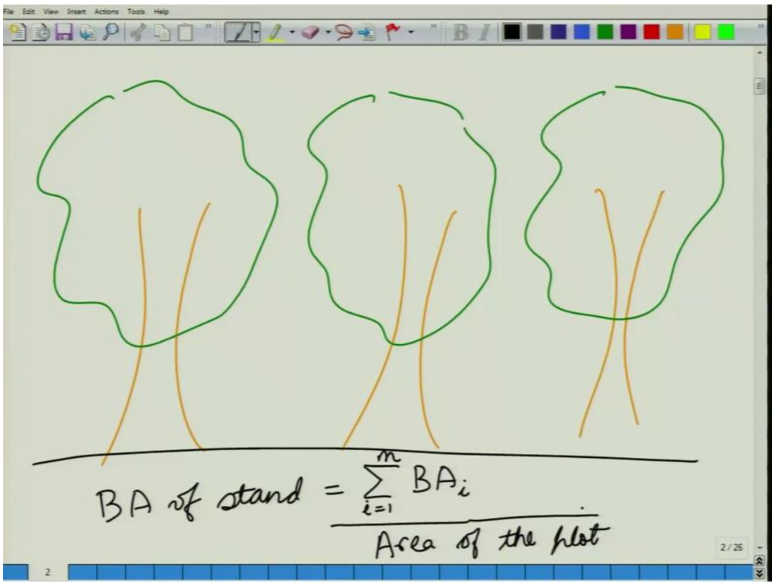

So, if we have a number of trees on a piece of land. Then the basal area of stand is given by the sum of the basal areas of all the trees where i goes from one to n where n is the total number of trees on that piece of land divided by the area of the plot. So, this plot could be the complete plot or it could be a sample plot.

Now, coming back to the slides generally the cross section at breast height is considered. So, essentially if we go back to the tablet. So, here we could take the basal area at any location, 1 2 or some other location 3 4 or so on, but generally the basal area at the breast height is taken to be the standard basal area. Now breast height as we know is 1.37 meters in the case of Indian conditions.

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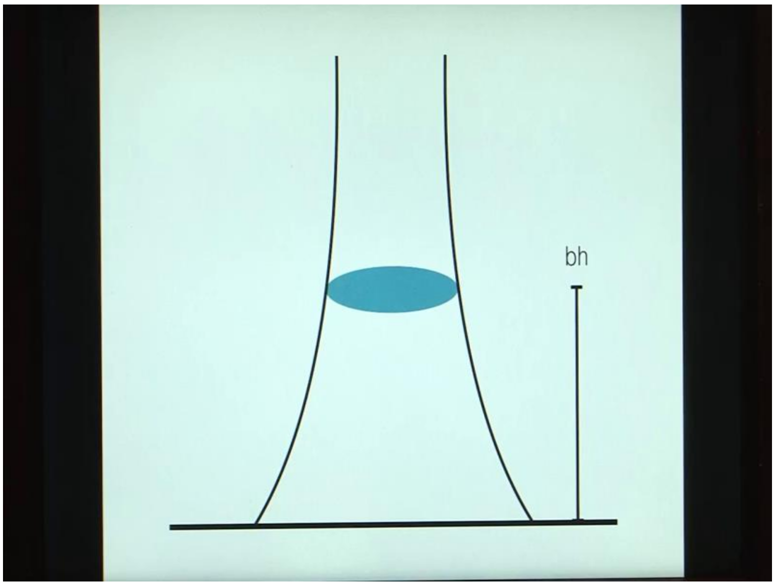

So, like this picture shows us that if we take a tree trunk we measure the breast height, and we take the cross sectional area at the breast height and that would be called the basal area.

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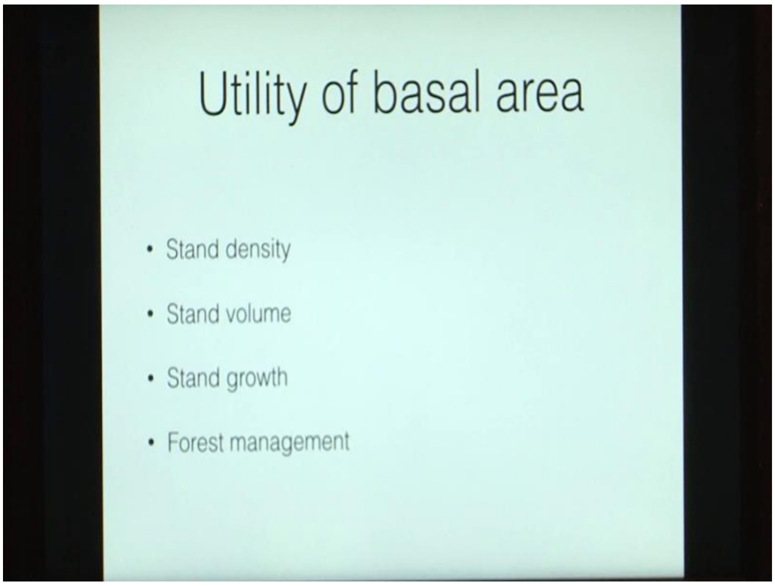

Now why do we need to know these basal areas? What is the utility of basal areas?

So, we use basal areas as a measure of the stand density, now stand density can be calculated in 2 ways. You can calculate the number of trees per unit of land that would be the number density of the stand, or you can take a basal area density which is the basal area of all the trees on that plot of land divided by the total area of the land. So, that essentially gives you the area of the land or the proportion of the land that is occupied by the projections of the basal areas of the various trees that are there.

So, coming back to the slides. So, basal area can be used to measure the stand density. It can also be used to measure the stand volume.

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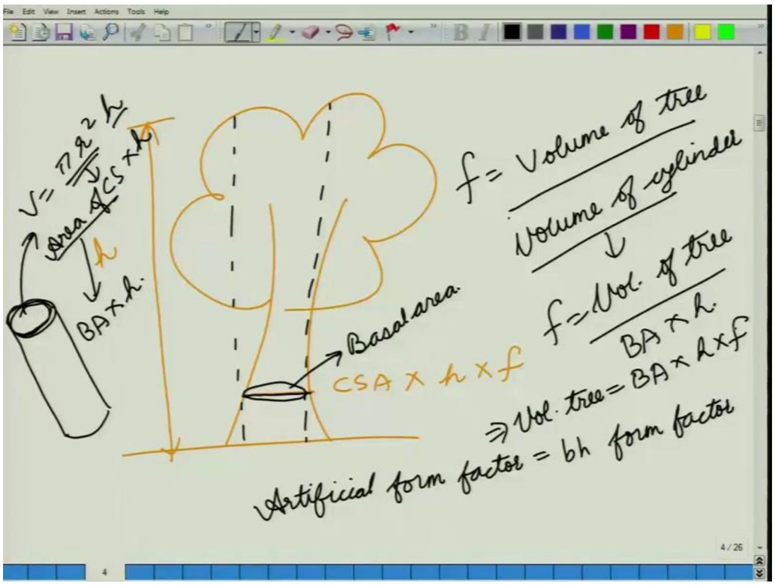

So, as we did before if we consider a tree we have this cross sectional area, if you multiply it by the height of the tree. So, cross sectional area multiplied by height, multiplied by the form factor. So, form factor if you remember f is the volume of tree divided by volume of cylinder.

Now, the artificial form factor if you remember. So, when we are talking about the artificial form factor, which is the most common form factor also known as the breast height form factor. Here are cylinder is a cylinder with the cross sectional area which is equal to the basal area, and height is equal to the height of the tree. So, in that case when we are taking this cross sectional area, and we draw a cylinder. The height of the cylinder is the same as the height of the tree. And the cross sectional area of the cylinder is the same as the cross section of the tree at the breast height, which will also be equal to the basal area.

So now as we remember if we consider a cylinder the volume is given by pi r square h. Now if it considered any of the ends. So, they are circle. So, pi r square is the area of cross section multiplied by the height of the cylinder. Now area of the cross section in this case is the basal area. So, basal area multiplied by the height. So, if you come to this equation the form factor will be given by f is equal to the volume of tree divided by the basal area into height h. So, we can find out the volume of tree is equal to the basal area multiplied by height multiplied by the form factor. Now here the cross sectional area and the basal area are the same. So, this will give us the volume of the tree.

Now, coming back to the slides. So, basal area can be used to find out the stand density or the stand volume. Now changes in the stand density or the stand volume will give us an indication of the growth of the stand. And why are these important these are important in the case of forest management, because they tell us what sort of prescriptions should be giving to our forest stand to meet our objectives.

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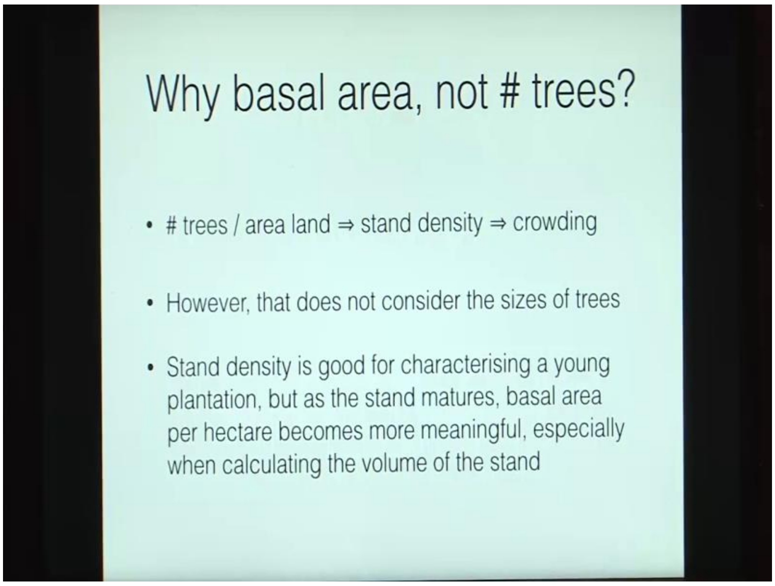

So now the next question is why do we take basal area and not the number of trees. So, for instance if you had a plot of land.

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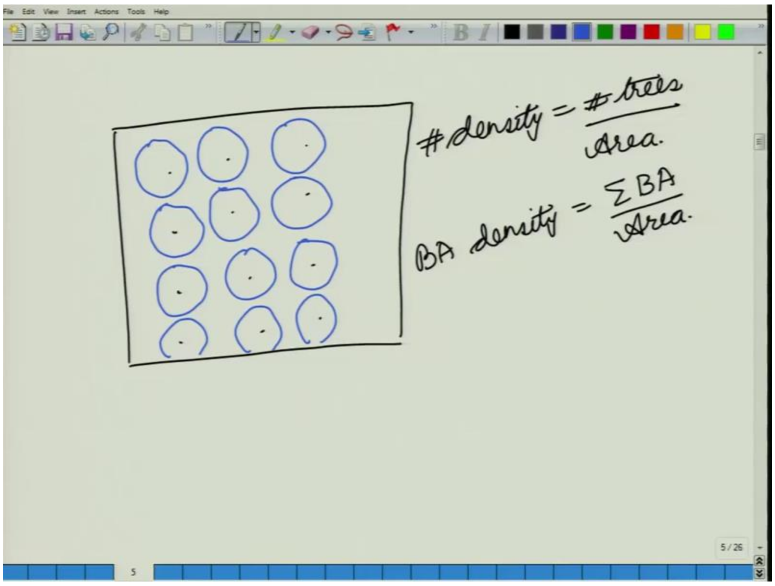

So, this is your plot of land you could count the number of trees that are there in the plot of land. And you can find out the number density which is equal to the number of trees upon the area of the sample plot. Now we could use this number density, but then why are we going for the basal area the basal area density which is given by the sum of the basal areas of all the trees divided by the area. So, why do we go for the basal area and not for the number of trees.

So now coming back to the slides. So, number of trees per area of land gives us the stand density or the number density of the stand, which can be used as a proxy for the amount of crowding that, is being observed in the stand. However, if we only considered the number density we would not be considering the sizes of the trees.

So, in the beginning when all our saplings are very thin; so stand density is a good characteristic for a young plantation, but as the stand matures the basal area per hectare becomes more meaningful, specially when calculating the volume of the stand. So, what it is telling us is that if we move back to the tablet.

So, whether our trees are thin as in this stand, or whether our trees have very big stem diameters. The stand density is the same in both the cases or the number densities are same; however, if we calculated the basal area density then we can observe that in the case of this blue stand the amount of crowding is much more as compared to the black stand.

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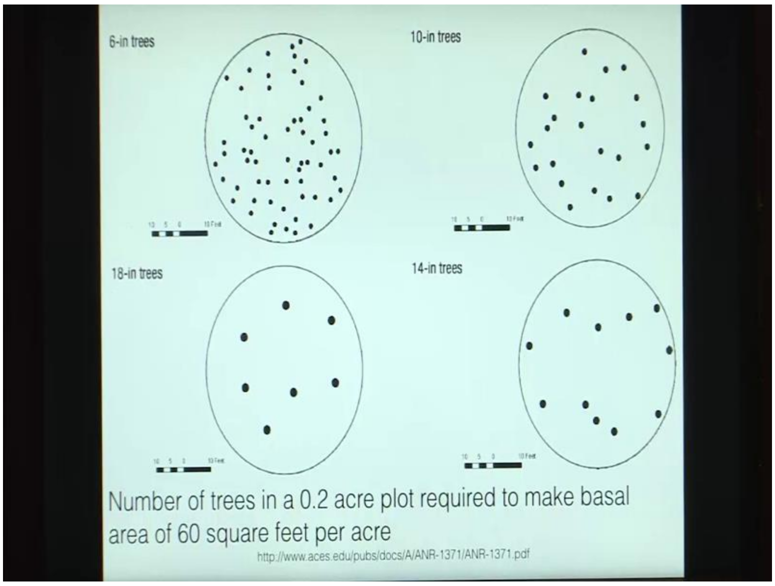

Or to show it in another representation here we see the number of trees in a 0.2 acre of plot that is equal to same basal area of sixty square feet per acre. So, here we can see that if our trees have very small diameters as in this case. So, here we have only 6 inches trees. So, the diameter is 6 inches. So, there are a number of trees that are making up the same basal area of sixty square feet per acre. If we increase the diameter of the trees the number of trees would decrease it would further decrease with 14 inches and even further in the case of 18 inches

So, in all these cases the basal area density is the same, but the number stand density is different. So now, to take an example.

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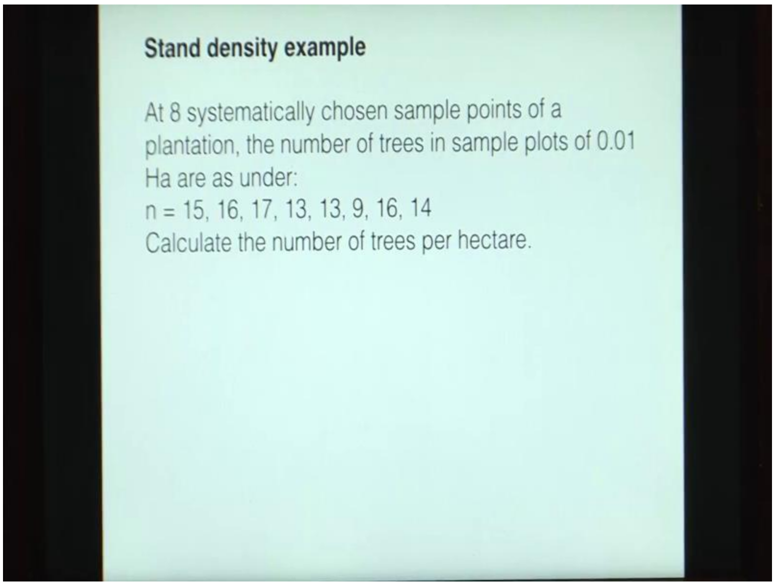

Here we have at 8 symmetrically chosen sample points of a plantation, the number of trees in sample plots of 0.01 hectare are as under. And we need to calculate the number of trees per hectare. So, what do we have here? We have 8 sample plots and in each of the sample plots the number of trees has been counted. The area of each sample plot has been given as 0.01 hectares, and we need to calculate the number of trees per hectare. Now number of trees per hectare would give us the number density in the stand. So, how do we solve this problem?

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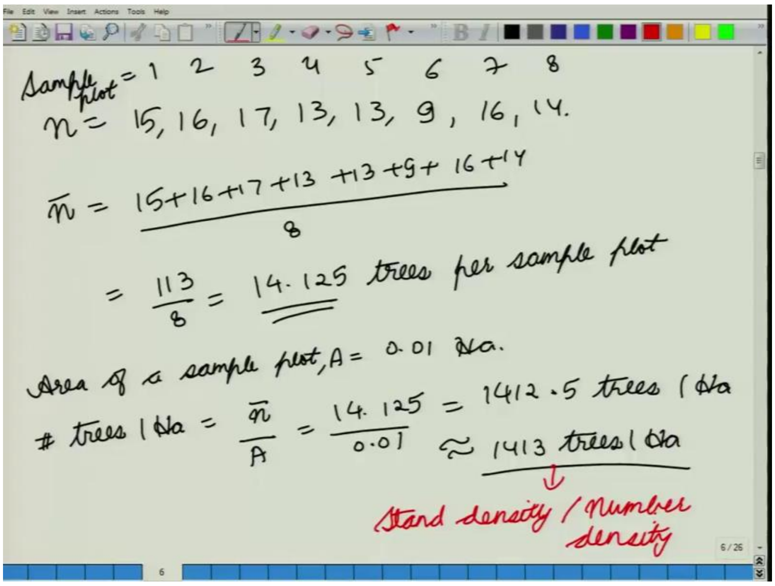

We have n is equal to 15 16 17 13 13 9 16 and 14. So, if we wanted to, so these are all different sample plots. So, sample plot 1 2 3 4 5 6 7 8. So, what is the average number of trees per sample plot? How do we find that out we calculate the average which is 15 plus 16 plus 17 plus 13 plus 13 plus 9 plus 16 plus 14 whole divided by the number of sample plots which is 8. So, here we get 113 divided by 8 is equal to 14.125. So, we have 14.125 trees per sample plot. So, this is the average number of trees per sample plot.

Now, what is the area of a sample plot? It is given to be 0.01 hectares. So, what are the number of trees per hectare? That would be n bar divided by this area a which is 14.125 divided by 0.01 is equal to 14, 12.5 trees per hectare or we could also down rid of to give 14, 13 trees per hectare. Now this value that we are getting is the stand density, also known as the number density. So, this is how we do these calculations.

Now, how do we calculate the basal area of a tree? So now, coming back to the slides.

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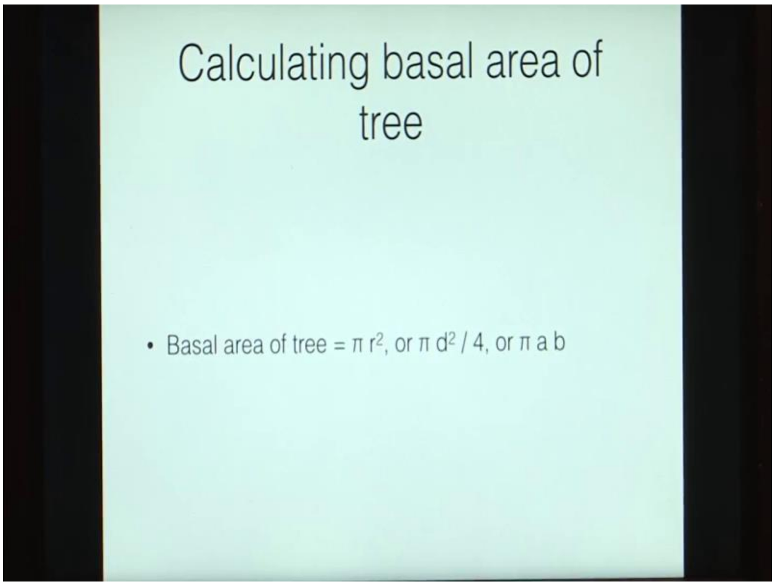

If we considered a tree to be having a circular cross section. So, in which case we will be having a tree.

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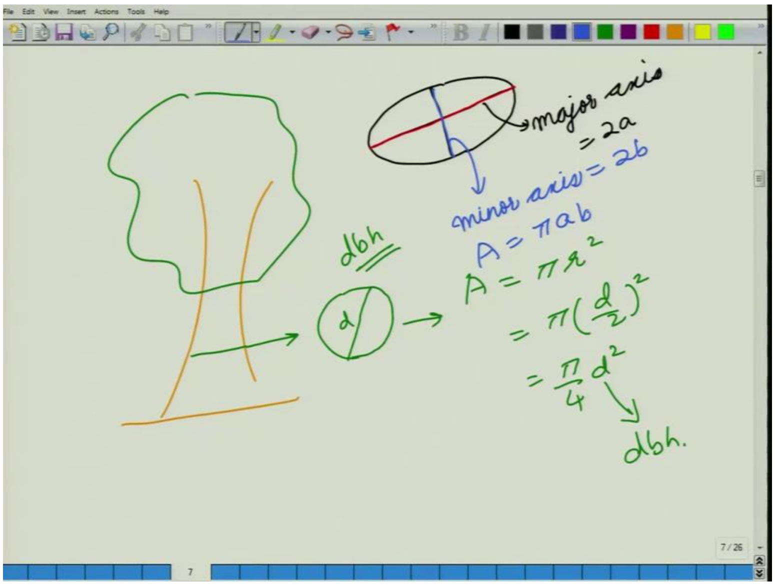

So, you took a sample here and it is circular, when it is circular the diameter. So, this is it is diameter. So now, because when we are calculating the basal area we are taking our samples at the breast height. So, in that case the diameter is equal to the diameter at breast height also known as the d b h.

So, if we considered a circular cross section the area is given by pi r square or pi d by 2 square or pi by 4 d square. And here r d is equal to the d b h. Now suppose we considered our cross sectional area to be elliptical. So, as you remember in the case of an ellipse we defined 2 axis the major axis is represented by 2 a. So, let us represent this is the major axis and this is the minor axis which we define to be 2 b. So, in this case the basal area will be equal to pi times a times b.

So now coming back to the slides.

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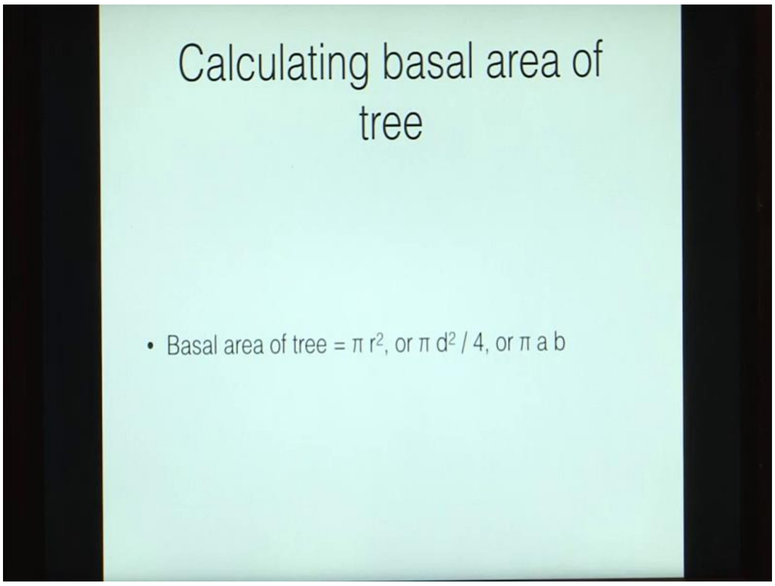

So the basal area of the tree will be given by pi r square then it is a circular cross section. Or which can also be written as pi d square by 4 or it can be written as pi a b if we considered at to be an elliptical cross section. So now, let us look at an example.

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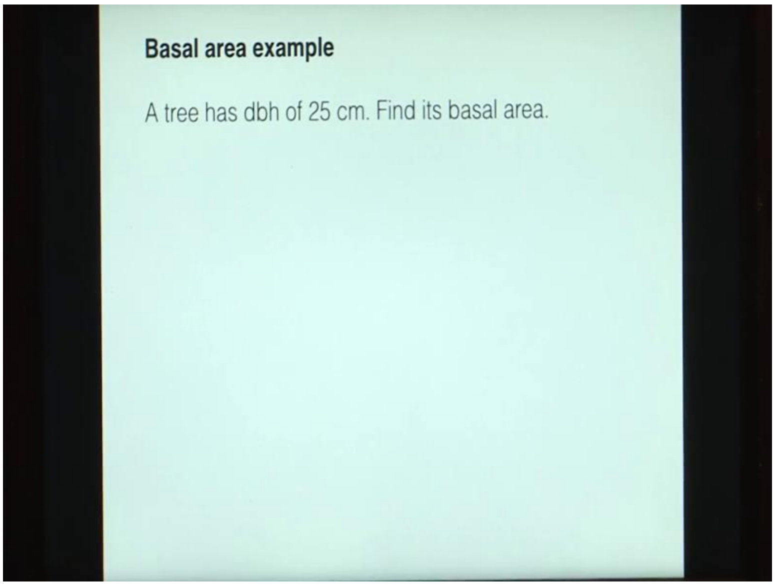

A tree has a diameter at breast height of 25 centimeters and we are required to calculate the basal area. So, we are given the d b h to be 25 centimeters what is the basal area. So, how are we going to solve it?

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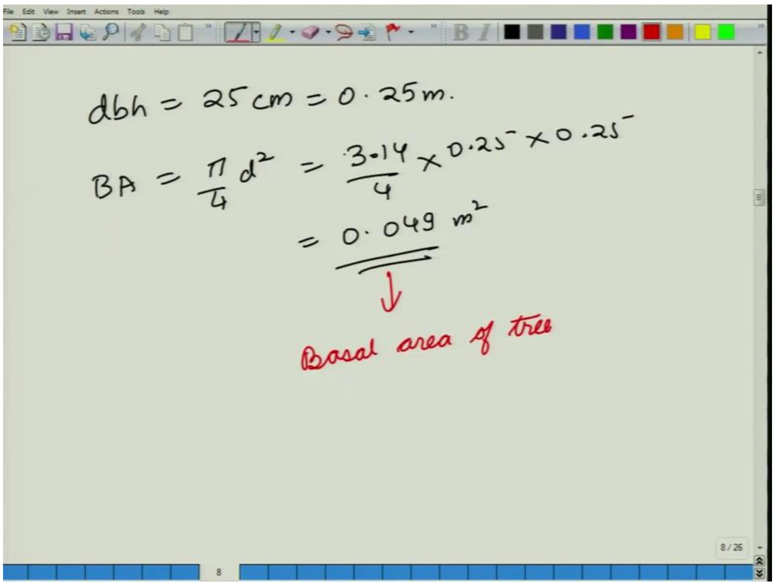

We are given That the d b h is 25 centimeters. Now I would recommend that in all the problems that you are solving you should convert everything into meters. Let us follow single conventions. So, it will be 0.25 meters.

Now, the basal area will be given by pi by 4 d square is equal to 3.14 by 4 into 0.25 into 0.25, which is equal to 0.049 square meter. So, this value of 0.049 square meters is the basal area of the tree. So, it is simple to calculate.

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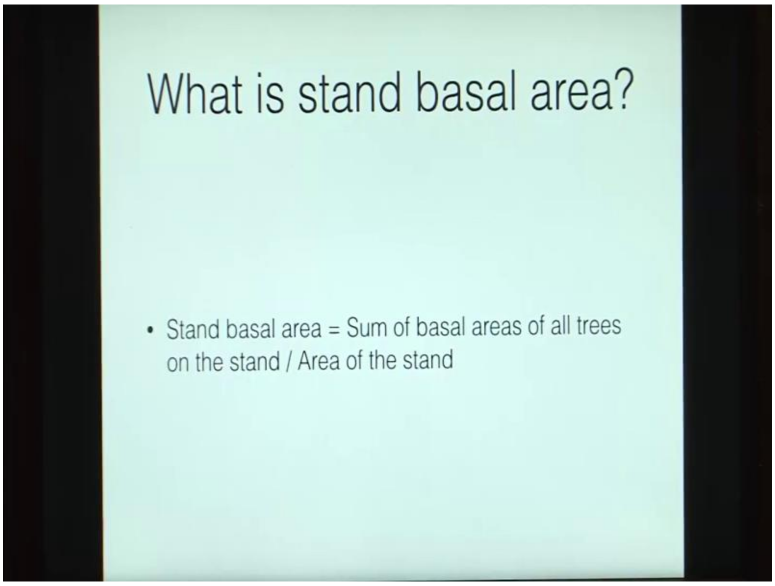

So now let us move to another topic. What is the stand basal area? So, remember that in the case of a stand we have a number of trees. So, the stand basal area is given by the sum of the basal areas of all the trees on the stand divided by the area of the stand.

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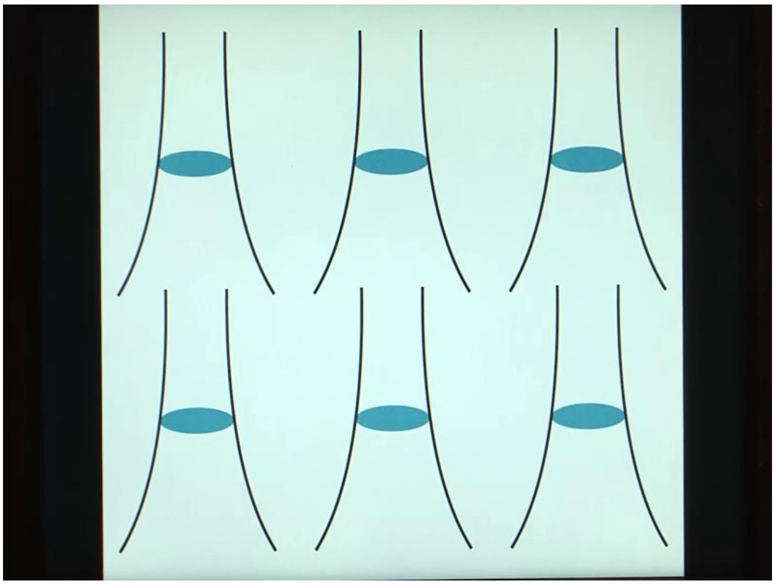

To put it in other words, suppose we have a stand that has 6 trees. So, and it is area is suppose capital a. So, the stand basal area will be given by the sum of the basal areas of all these 6 trees divided by which is the area of the stand.

Now, how do we calculate stand basal area? So, we have a number of methods of calculating the stand basal area one of which is the most simple one you just add up all the basal areas and divided by the number of the trees, divided by the area of the stand, but there are also some other methods.

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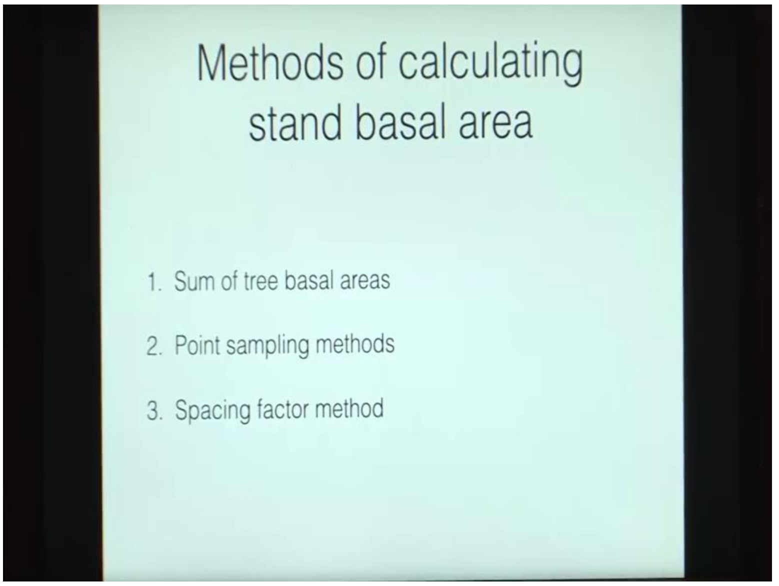

So, the first one is the sum of tree basal areas the second one is known as point sampling methods where we shall go to in a later class and there is also a spacing factor method that we shall also discuss later.

So, today we are going to see how do we calculate the stand basal area as the sum of the tree basal areas. So, let us look at an example.

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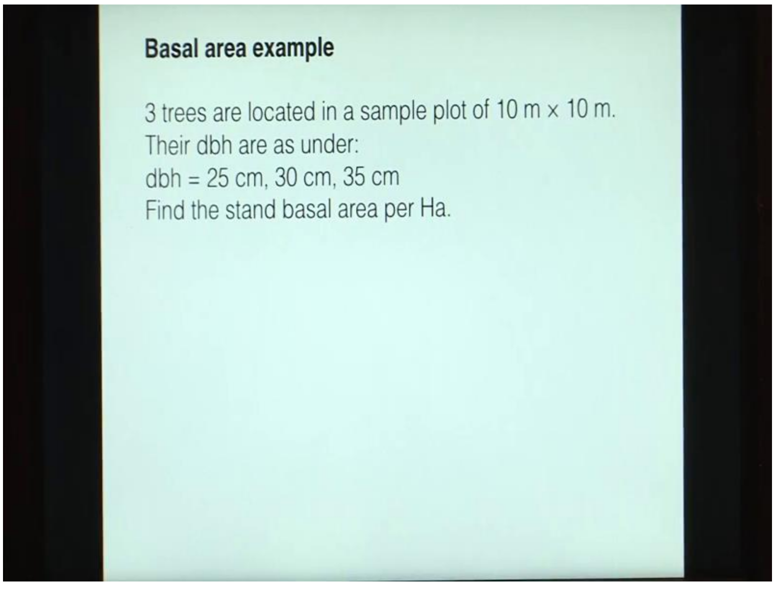

So, here we have 3 trees are located in a sample plot of 10 meters by 10 meters. Their diameters at breast height are given as 25 centimeters 30 centimeters and 35 centimeters and we are required to find out the stand basal area per hectare.

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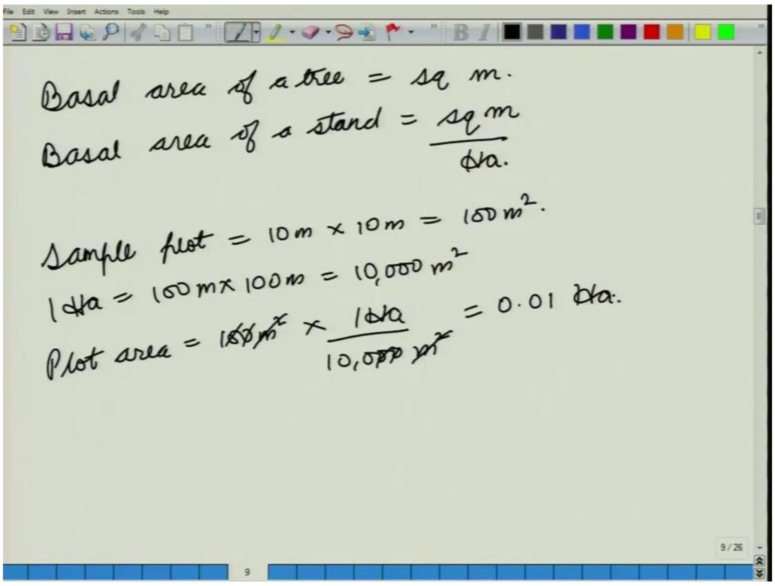

Now, here we need to remember that the basal area of a tree will be given in square meter, but the basal area of a stand is normally represented as square meters per hectare. So, it is the basal area of all the trees combined divided by the area of the plot the area of the plot is generally represented in hectares.

Now, in our question we are given that the sample plot is 10 meters by 10 meters which is 100 square meters. Now when a hectare is defined as 100 meters by 100 meters, which is 10000 square meters. So, the sample plot or the plot area which is 100 square meters multiplied by one hectare upon 10000 square meters. So, these get cancelled out which is equal to 0.01 hectare. So now, that is the area of the sample plot.

Now, we are also given that.

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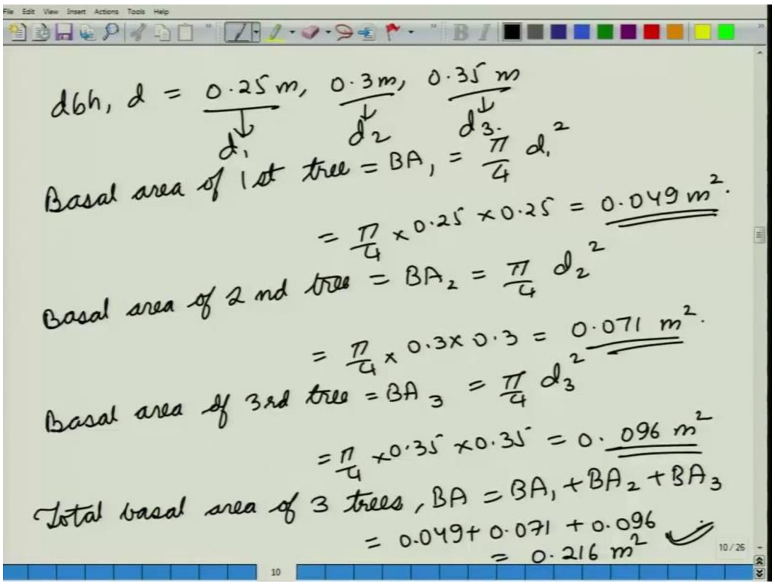

The d b h let us represent it by d are 25 centimeters or 0.25 meters 30 centimeters or 0.3 meters and 35 centimeters that is 0.35 meters.

Now, for the first tree for this tree of 0.25 meters the basal area of first tree, let us call it basal area one is given by pi by 4 d 1 square where d 1 is 25 centimeters. So, this will be equal to pi by 4 into 0.25 meters into 0.25 meters or as we calculated in the previous example it is 0.049 square meters.

Now, the basal area of the second tree will be given by BA 2 which is equal to pi by 4 d 2 square or pi by 4 into 0.3 into 0.3 which is equal to 0.071 square meters. And the basal area of third tree or BA 3 is given by pi by 4 d 3 square which is pi by 4 into 0.35 into 0.35 is equal to 0.096 square meters.

So now this is d 1 this is d 2 and this is d 3. So now, we have calculated the basal areas of all these 3 trees. Now as you can see all these 3 basal areas are given in the unit is of square meters.

Now, the total basal area of 3 trees or let us call it BA will be BA 1 plus BA 2 plus BA 3 which is equal to 0.049 plus 0.071 plus 0.096, which is equal to 0.216 square meters now this is the basal area of all the 3 trees.

Now, as we have seen in the previous page we have calculated the plot area that is 0.01 hectares.

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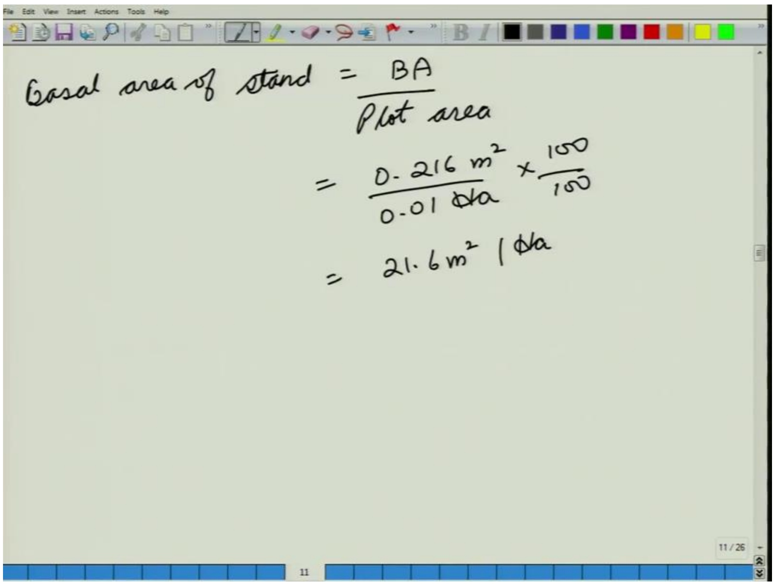

So now, what is the basal area of stand is given by the basal area divided by the plot area. Now basal area we are founded to be 0.216 square meters. So, it is 0.216 square meters divided by the plot area that we have calculated to be 0.01 hectares. So, 0.01 hectares. So, multiplying both sides by 100 we will get 21.6 square meters per hectare. So, that is the basal area of the plot.

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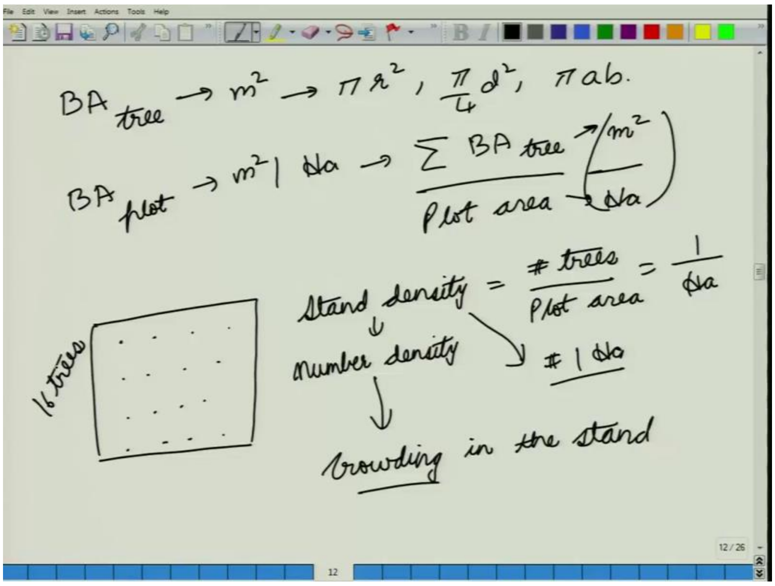

Now, to sum up, we can say that Basal area of a tree is given in square meters and it is pi r square or pi by 4 d square or pi a b. Basal area of a plot is given by is given in meter squares per hectare and it is the sum of the basal area of all the trees, divided by the plot area. Now this figure is given in meter square this figure is given in hectares which is why we get to this unit of meter square per hectare. Also why do we need to calculate the basal areas? It is because we can calculate the stand density or the number density.

So, stand density which is given by the number of trees, divided by the plot area. This thing is also known as the number density; so the unit here. So, number of trees does not have any unit. So, let us call it one. And the plot area will be given in hectares. So, the stand density is given in number of trees per hectare. But in the case of the stand density we are only calculating the number of trees that are there in the stand and divided get by the area. But this figure, so we can use this density or the number density to be a proxy for the amount of crowding that is there crowding in the stand.

Now, why do we need to know about the amount of crowding that is there in the stand, because if you have a lot of crowding in the stand then you have a great amount of competition in the stand. So, essentially all these trees. So, in this plot we have 4 4 za 16 trees. So, all these 16 trees are competing for the same resources that are for sunlight for water for minerals for air and so on.

So, if you have a lot amount of crowding then you will be having much more competition in the stand if there is much more competition then your resources are scars. If the resources are scars then your trees will not be able to put up the amount of growth that we want them to put up.

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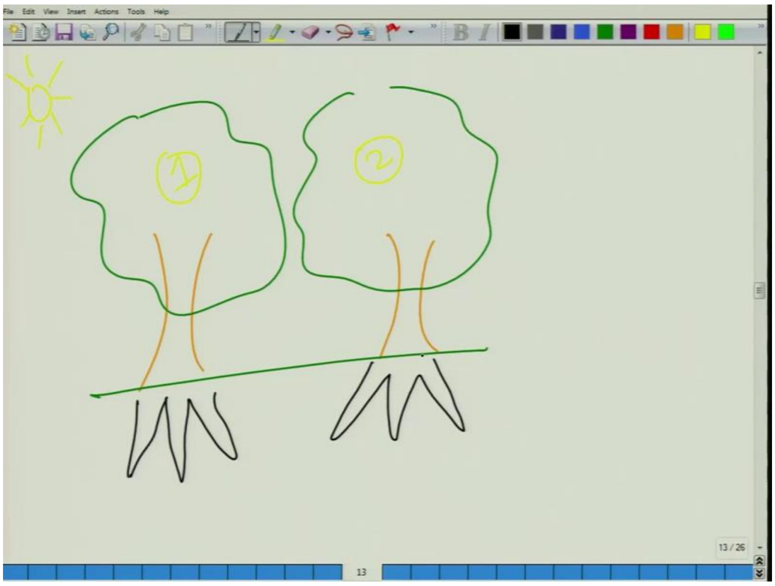

So, essentially if you have a tree here and tree here. This tree is also having a big kind of (Refer Time: 25:04) and this tree is also having a big kind of (Refer Time: 25:05). So, if you have the sun at this point. So, your tree number one will be putting a big shadow on your tree number 2. So, your tree number 2 will not be getting sufficient sunlight.

Similarly, the roots of the first tree will also be taking water from the same water table and will be taking minerals from the same soil. So, in which case both these trees will be undernourished. Now they will be undernourished only if there is an appreciable amount of competition between both of these. Because if your density is very less then you have ample resources and very less individuals to feed up on it. So, in that case we can have even more number of trees, but when your trees are much more in number as compared to the amount of resources then your resources are getting scars.

Now, when we are talking about the number density then we are calculating the crowding in the stand in terms of the number of trees that are there, but now consider this situation in which let us consider these 2 plots of the same size.

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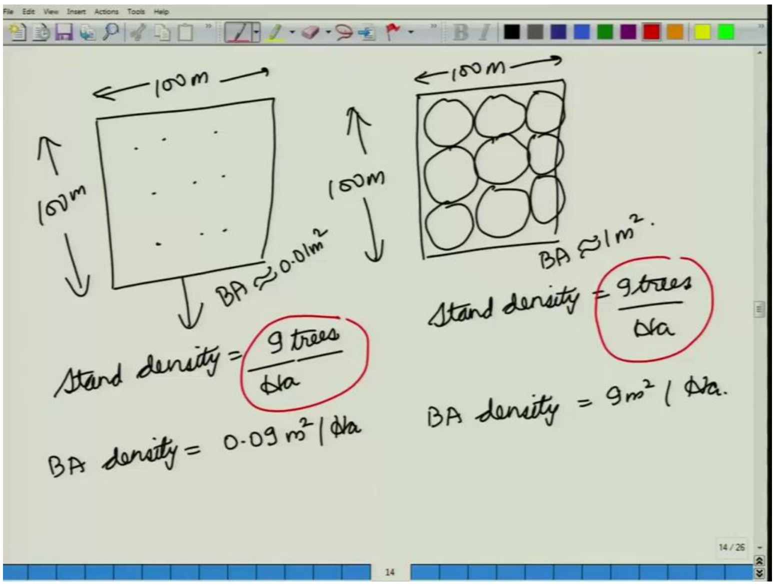

And both these plots are having say 9 trees, but in the first case all these 9 trees are having very small diameters. And in this case we have trees that are literally touching each other because they have grown in size.

So, in this case your stand density and let us suppose both these plots are 100 meters by 100 meters. So, the stand density in the first cases 9 trees per hectare. And here also the stand density is 9 trees per hectare. But in the first case, suppose because these trees are very small in diameters. So, let us consider that the basal area per tree is approximately equal to 0.01 square meters and here the basal area is close to one square meters.

So, we will have the basal area density here given by the stand density multiplied by the average basal area, which will be 0.096 square meters per hectare, but in this case we will have basal area density is equal to 9 square meters per hectare. So, essentially the stand density 9 trees per hectare here and 9 trees per hectare here we will not be able to tell us the amount of competition in both these stand, because 9 trees per hectare is constant between both the stand. So, it is showing us that both these stands have n equal amount of competition which is not true because in the case of the second plot we have much more bigger size trees.

But your basal area density of 0.09 and here it is 9. So, your basal area density is able to tell you that the amount of competition in the second stand is 100 times as much as the amount of competition in the first stand. So, when do we use the stand density or the number density we use it in the case of young plantations, because in the case of young plantations you have very thin diameters. In the case of older plantations we go for the basal area density.

So now that we know how to calculate the basal area of a tree and the basal area density of a stand we shall look into these topics in further detail in the next class.

Thank you for your attention. [FL].