Forests and Their Management
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Module - 03
Forest Soils
Lecture – 02
Major Soil Types

[FL] We move forward with our discussion on Forest Soils, and today we will look at the kinds of soils that we have or the Major Soil Types, the classification of soil types.

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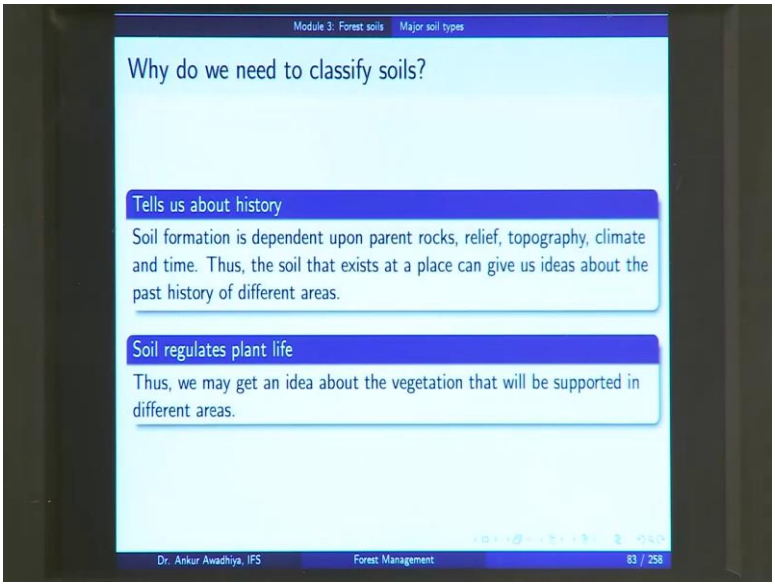

The first question that arises is why do we need to classify the soils? Well, there are 2 reasons. One, soils tell us about the history of a place. As we saw in the previous lecture, soil formation is dependent upon parent rocks, relief, topography, climate and time.

So, the kind of soil that is present in an area can give you an idea about what kind of parent rocks are there? what was the relief of this area? what was the topography of this area? when the soil was formed? what was the climate of this area? and probably also how long has it taken for this soil group be formed in this particular area? So, we can have a good discernment about the past history of different areas, if we study the soils. Also, the classification of soils is important because soil regulates the plant life.

So, when we are doing silviculture, when we are raising a forest rock, then we need to know what kinds of crops can be raised in different areas. So, the question is, whether or not are particular species can be grown in the area of interest. So, there are some species that for instance may require a well-drained soil. There could be some other species that require a soil that retains a lot of moisture probably even a water-logged soil. So, if we see the soil of an area, we can make an inference about what kind of species can be grown in that area. So, that permits us to avoid the failures that that were possible, if we did not know about the correlation between different species and the soil types of the area.

So, we can get an idea about the vegetation that will be supported in different areas. Now, soil classification is so important that from very early on in our civilization, we have had different kinds of classifications.

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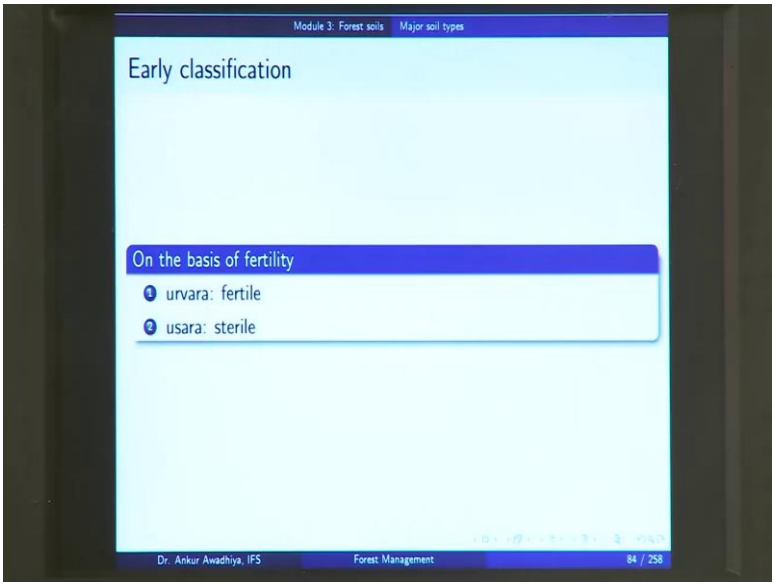

And, one of the earliest classifications, divided soils into 2 categories, urvara soil and usara soil. Urvara soil is a fertile soil. Usara soil is a sterile soil. So, if there is a soil that can support a wide variety of plants, then it is a fertile soil. If it cannot support, then it is an infertile soil.

So, this is a very rudimentary classification, and does not serve our purpose to quite an extent, because this classification does not tell us a lot about the qualities that are there in the soil. So, you can be having in usara soil and probably that soil is usara, because it is

not having enough amount of water. So, if you give it irrigation, probably it will be able to raise the crops or there could be an usara soil which is deficient only in one particular mineral, say it is having a lack of potassium. So, you can very easily convert it into an urvara soil by adding potassium, but then just by telling that this soil is a usara soil does not give us any management inputs that we could make use of.

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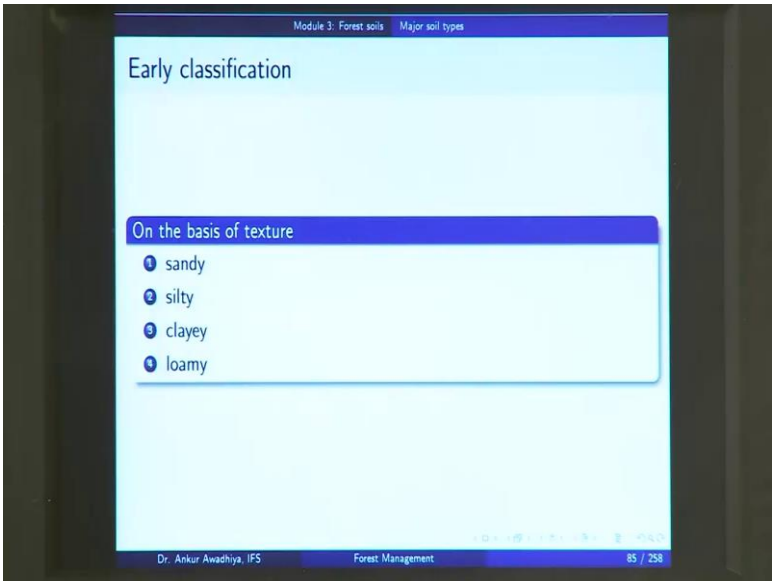

Another early classification is on the basis of texture. So, as we saw before, we can have sandy soils, we can have silty soils, we can have clay soils or we can have loamy soils. Now, in this classification, the loamy soil is considered to be the best kind of soil because it has enough amounts of sand silt and clay, and so, it is able to support a wide variety of plants.

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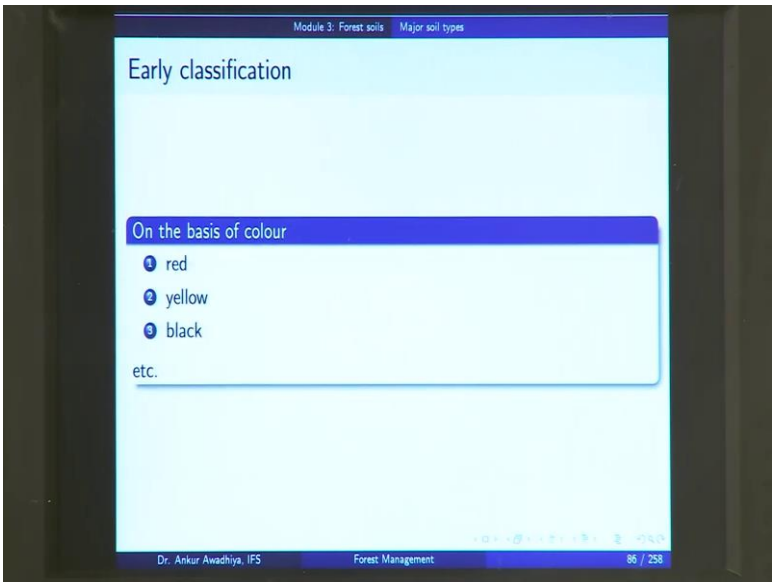

Another early classification was on the basis of colour. So, what does the soil looks like? is it a red coloured soil? is it a yellow coloured soil? is it a black coloured soil? But here again, we can gain some correlations about the properties of the soil, but this classification does not tell us a lot about the properties of the soil.

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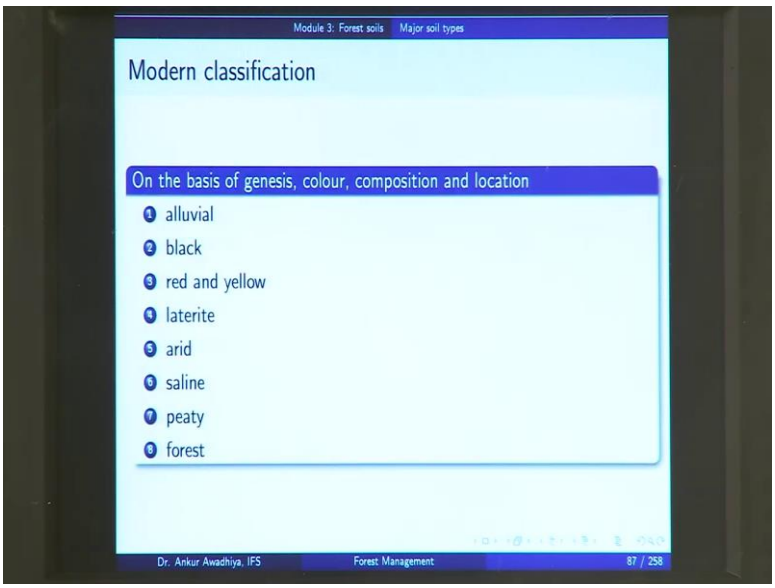

And so, we moved to the modern classification. Now, the modern classification classifies the soil on a number of basis. It classifies it on the basis of it is genesis or how the soil originated, the colour of the soil, the composition of the soil, the location of the soil, and

if we know something about all of these different characteristics of the soil, then the other characteristics that have been left out can very easily be discerned.

So, for instance, if you know that a soil is an alluvial soil, then you will then you can make an inference that probably it is very near to a water body, or probably this is a very fine soil that has been deposited over time, and this soil has enough amounts of clay, and this soil supports these many species of plants and so on. So, on the basis of genesis, colour, composition, and location, we divide soils into 8 different categories. So, we have the alluvial soil, black soil, red and yellow soil, laterite soil, arid soil, saline soil, peaty soil and forest soil. And, we look at each of these in more detail now.

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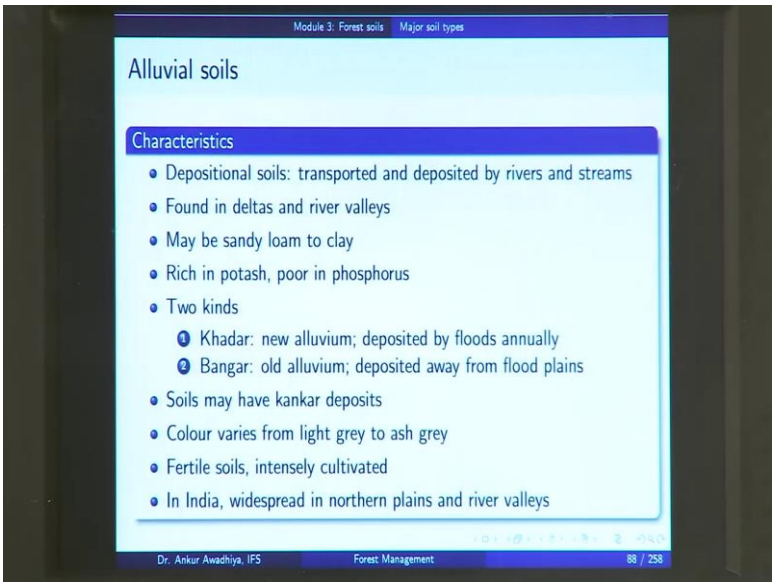

So, let us begin with alluvial soils. So, alluvial soils are depositional soils. They are transported and deposited by rivers and streams. So, how so, we are talking about the genesis of these soils, and what are the locations in which these soils are found.

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So, if you consider a hill, and on this hill there is a stream that is flowing, and then it this stream gets into the plain areas. Now, when this stream is moving in the mountainous regions, then it has a greater speed, because it has a large slope on which this stream is flowing. Now if you have water that is flowing at a great speed, in that case, it will be able to retain a lot amount of sediments, which will move along with the stream. So basically, we were having some weathering that occurred in these areas. There was also some erosion that happened, and all of these sediments are now moving with the water, because it is moving at a faster speed, but then when it enters into these plain areas.

So, now the speed of the river has come down. It has earlier it was moving on a huge slope now it has come to a flat region. So, when it moves from this from this steep slope to a flat region. the speed now reduces. Now when the speed reduces, the capacity of the stream to carry the sediments also reduces. So, what happens then, the stream then leaves out these sediments. So, these sediments now just settle down, and the water is moving about them. Now, these sediments get deposited in these areas - in the floodplains, and these sediments form the alluvial soil.

So, what is the genesis of the alluvial soil? It is a soil that is formed through transportation and deposition by streams and rivers. So, where will you commonly find these alluvial soils? You will find them in river valleys, and you will find them in deltas, because in these regions the speed of the water is very slow. Now these alluvial soils in

terms of texture, they can be sandy loam or they can even be clay. Now, typically there will be sandy loam, in these areas, in this area, because early on the sandy loam will be deposited by the river, and in the far off areas, it will be more of a clay composition, because if we had only fine particles, they will only be able to be moved to the later on stages. So, sandy loam in the earlier areas; clay soil in the later areas downstream.

These soils are rich in potash, but are poor in phosphorus. And, there are 2 kinds of alluvial soils; you have khadar and you bangar. Now, khadar is the new alluvium, which is deposited by the floods annually. And, bangar is the old alluvium which was deposited away from the flood plains in historical times. Now, these soils may have kankar deposits. What is kankar? Kankar is calcium carbonate. So, in a number of our hills, we have calcium carbonate, and that also gets moved along with the streams, and this kankar is also deposit a deposited along with the alluvial soils. So, in this case, we can say that the amount of calcium that is present in this soil is also substantial.

The colour varies from light grey to ash grey. These are fertile soils, and these are intensely cultivated. So, they are very fertile soils, and in a number of areas you will find that the forest that were growing on these soils have been cut, and these lands have been converted for agricultural use. In India, these soils are widespread found in northern plains and in the river valleys.

Next have a look at the black soil. Black soil is also known as regur soil or black cotton soil, because it is black in colour and it is used for the cultivation of cotton. These are clay soils, and these are deep and impermeable soils. Now, because they have a large deposit; a large amount of clay, they are impermeable as we saw in the last lecture that because clay has very fine sized particles, and very less number of pores or less quantity of pores. So, in so that makes it an impermeable soil. So, if you put water on it, probably the water will form a puddle.

These soils have a high swell shrink character. What is this swelled shrink character? They swell and become sticky when they are wet, and they shrink when they are dried. So, depending on the amount of water that is there, the volume of the soil changes a lot, and this gives them self-ploughing character, since large cracks develop in the summer season. So, when these soils become dry, the volume reduces and that leads to the development of cracks, and in these cracks the water can very easily reach inside, and so,

these cracks facilitate the absorption of water permitting the rain fed agriculture, and cotton is widely cultivated.

These soils are rich in lime, iron, magnesium and potassium, and they generally lack phosphorus, nitrogen and organic matter. So, if you want to raise crops in these soils, you will probably have to add phosphorus, nitrogen and organic matter. The colour varies from deep black to gray, and in India, they cover most of the Deccan plateau.

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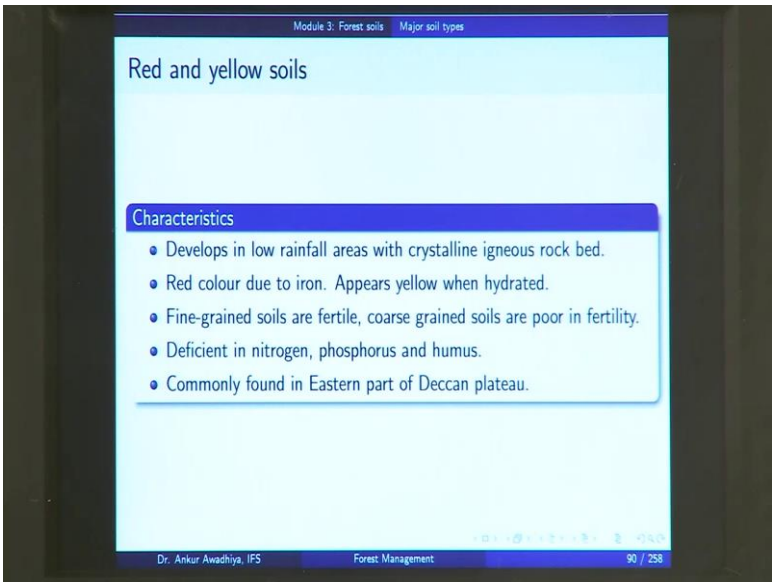

Next, we have the red and yellow soils. These soils develop in low rainfall areas with crystalline igneous rock bed. So, the kind of parent material is crystalline igneous rocks, and the climate is a low rainfall area. The red colour is due to the presence of iron, and when you add water to it, when it becomes hydrated, it becomes yellow in colour. These are fine grained soils that are fertile, and the coarse-grained soils amongst these will be poor in fertility. They are deficient in nitrogen, phosphorus and humus, and are commonly found in Eastern part of the Deccan plateau. So, they will be commonly found in areas like Odisha and Andhra Pradesh.

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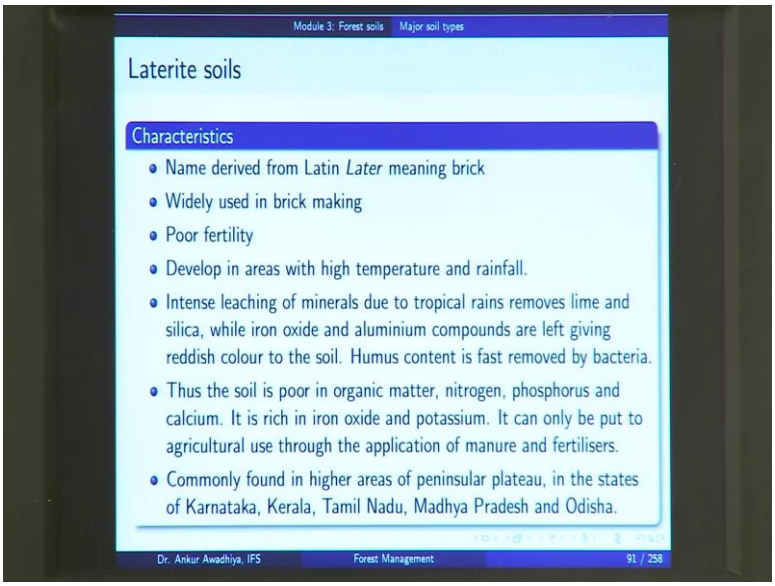

Next, we have laterite soils. Now, the term later is derived it is a Latin word; that means, brick. So, these soils are mainly used in the construction of bricks. Now, if you have a soil that is mainly used for brick making and not for agriculture, you can make an inference that this soil does not have a good amount of fertility. Otherwise, why would somebody want to use it for brick making?

So, these soils have poor fertility, the developing areas with high temperature and rainfall. Now, if you have high temperature in high amount of rainfall, any amount of organic matter that is there in these soils will very easier and very quickly get degraded, because of the microorganisms, because you have ample amount of water and you have high temperatures. So, generally the amount of organic matter in these soils will be very less, and also, there is an intense leaching of minerals due to the tropical rains. So, you have high temperatures, you have high amount of rain and so, a number of minerals that were found in these soils are constantly getting released out.

It removes lime and silica while iron oxide and aluminium compounds are left. So, iron oxide and aluminium are left which gives it the reddish colour. Humus content is fast removed by bacteria and so, you have the soil that is poor in organic matter. And, if it is poor in organic matter, typically it will also be poor in nitrogen, and it is also poor in phosphorus and calcium. It is rich in iron oxide and potassium. It can only be put to agricultural use through application of manure and fertilizers. It is commonly found in

higher areas of peninsular plateau in the states of Karnataka, Kerala, Tamil Nadu, Madhya Pradesh and Odisha. So, these are the characteristics of the laterite soil.

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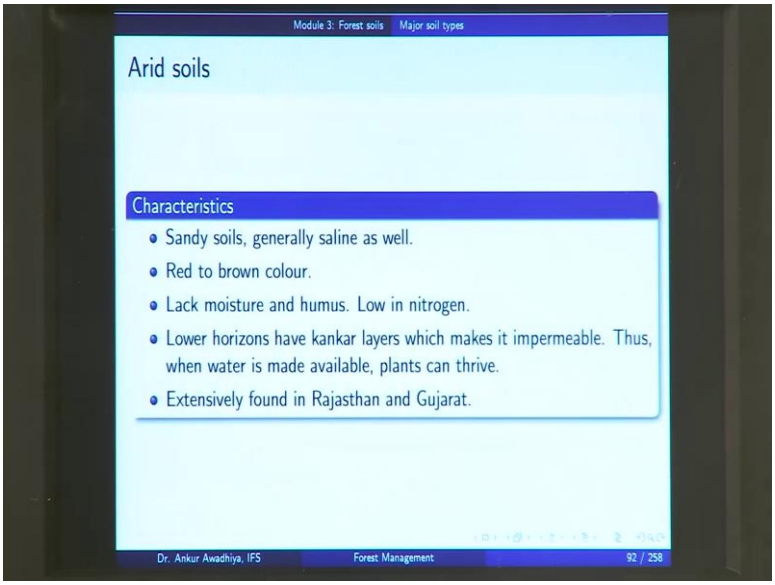

Next, we have arid soils. Now, the term arid means dry. So, these are dry soils. When you talk about a dry soil, you can think about the state of Rajasthan, in which you will be having huge quantities of these arid soils. So, if you think about Rajasthan, the first thing that gets into your mind is the sand. So, these are sandy soils, and typically they are highly saline as well.

So, when you say saline soil, it means that it has large amounts of salt in it typically, because there is little amount of rainfall to wash it away. So, these are sandy soils, which are generally saline as well, they have red to brown colour. They lack moisture and humus, and they are also low in nitrogen. The lower horizons can have kankar layers, which makes it impermeable, and thus when water is made available the plants can thrive.

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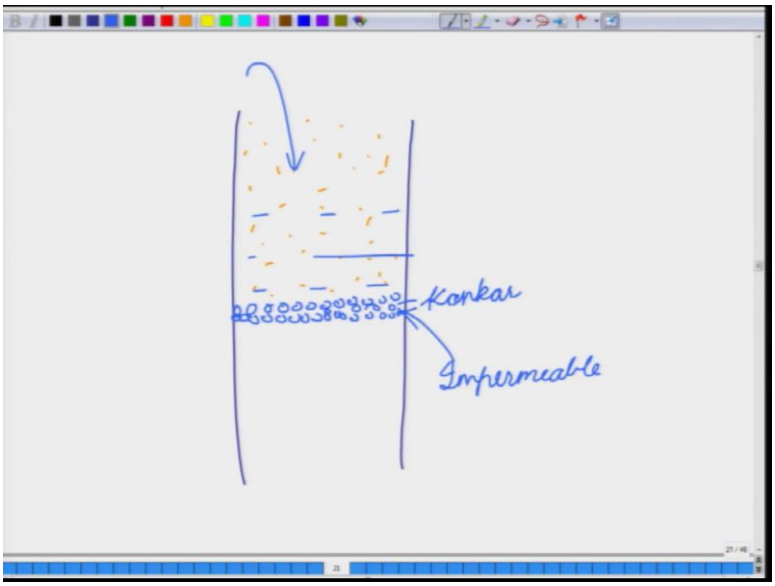

So, what happens with these soils is that if you look at the soil horizons, then here you have the sand, but then below this will be a layer of kankar nodules. So, these are the calcium carbonate nodules, and because of these kankar nodules, if you add water to this soil, then you will have water then gets localized into this area, because this layer is impermeable. And so, if you add water to these soils, you can use it for the cultivation of crops, even forest crops. So, when water is made available, plants can thrive. It is extensively found in the states of Rajasthan and Gujarat.

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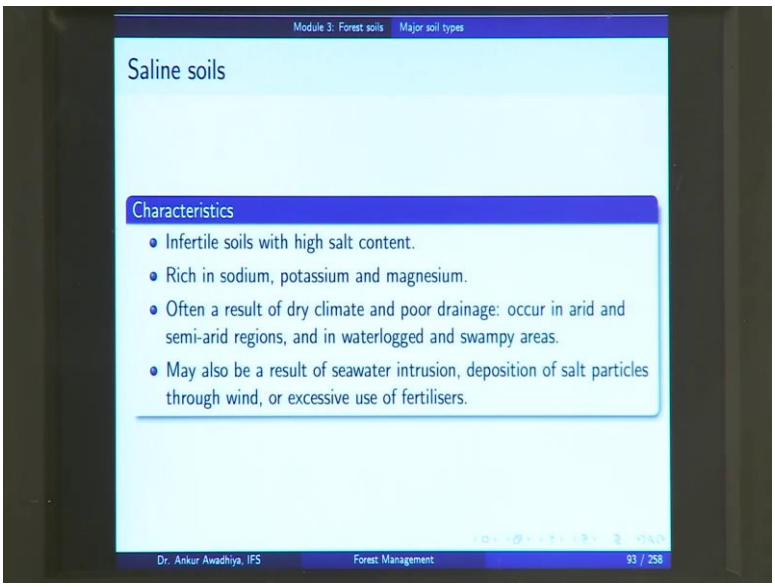

Next, we have saline soils. Saline soil is a soil that has a huge quantity of salt. Now because it has large quantities of salt, it is generally infertile. Now, why is it infertile? It is infertile because when you have a huge quantity of salt in the soil, then water is not getting absorbed by the roots because of the osmotic pressure. So, because of osmosis the you have a salty brine that is outside, and the root cells are unable to absorb water because of osmosis.

So, these are infertile soils with high salt content. Now when you talk about salt, the general salts are sodium chloride, potassium chloride, magnesium chloride and so, these soils will be rich in sodium, potassium, magnesium, and often they are a result of dry climate and poor drainage. So, again you have salts, if you have enough amount of water, if you have good drainage, then these salts will get washed away. But then, if you have salts in typically you have a dry climate and you have a poor drainage, because of which the salts are not getting washed off. And, they occur in arid and semi arid regions and in waterlogged and swampy areas, may also be a result of seawater intrusion or deposition of salt particles through wind or excessive use of fertilizers.

So, these are 3 other ways in which these soils can get formed. So, this is the genesis of these soils - they can be because of seawater intrusion, or deposition of salt particles through air, or excessive use of fertilizers, and once these salts are there, if you have less quantity of water; if you do not have a good drainage, these salts are going to stay because they are not getting washed away.

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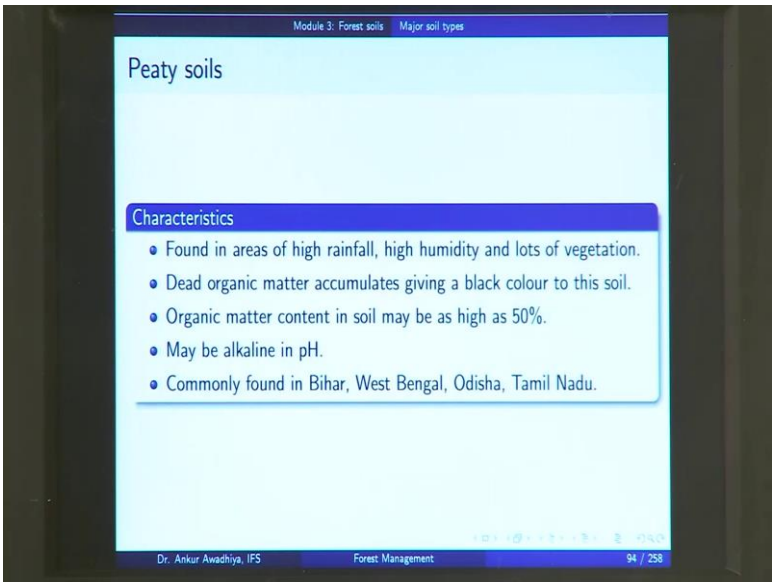

Next, we have peaty soils. Now, a peaty soil when you think about a peaty soil you should think about organic matter. So, this is a soil that has a huge quantity of peat in it and huge quantity of organic carbon in it. So, peaty soils are found in areas of high rainfall, high humidity and lots of vegetation. So, you have a good amount of rainfall; so, there is a profuse growth of vegetation. When there is a profuse growth of vegetation, you will also have a profuse amount of leaf litter that is falling on these soils, and if there is an anoxic condition you do not have sufficient oxygen, in that case these this leaf litter will not get fully degraded, and it will remain in the soil, and then and gradually convert it into a peaty soil.

So, you have dead organic matter that accumulates giving a black colour to this soil. The organic matter content in the soil may be as high as 50 percent. It may be alkaline in pH, and it is commonly found in Bihar, West Bengal, Odisha, Tamil Nadu. So, peaty soil areas of heavy rainfall, profuse growth of vegetation, lots of deposition of dead leaves, which are not getting degraded typically, because of an anoxic condition or because of alkalinity in the soil.

Then, we have forest soils. Now, remember that in all these different kinds of soils, you can have forests, but then typically most of these soils have been put into other uses. So, for instance, in the case of laterite soil it is being used to make bricks. In the case of

alluvial soil, it is being used for agriculture and so, we hardly have any forests that are seen in these soils.

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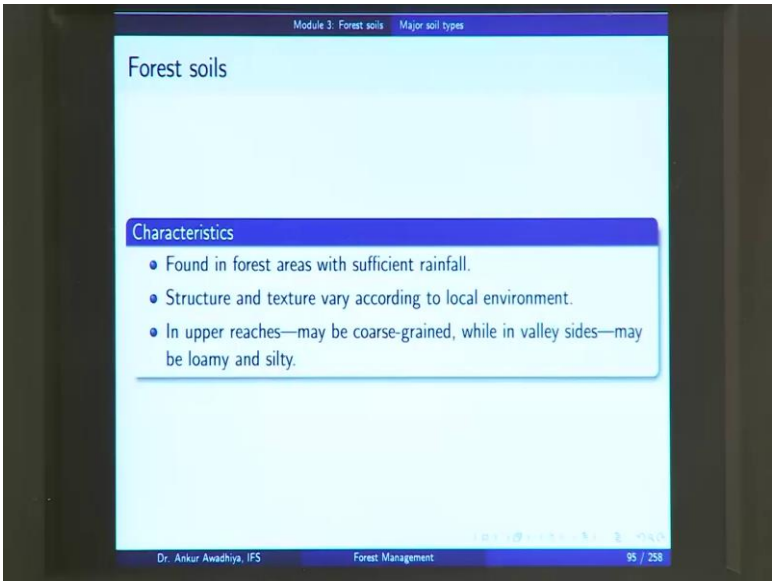

So, but in the case of the forest soils, because we have - we do not have much other uses for them so, the forests are still found there. So, forest soils are found in forest areas with sufficient rainfall. The structure and the texture vary according to the local environment.

So, this is not a soil classification in which you can very easily tell the characteristics. The only characteristic that you can probably say is that it is not a very fertile soil because of which it has not been put for agricultural uses. In upper reaches, it may be coarse-grained, in valley sides it may be loamy and silty. So, you cannot make a very good prediction about the forest soils.

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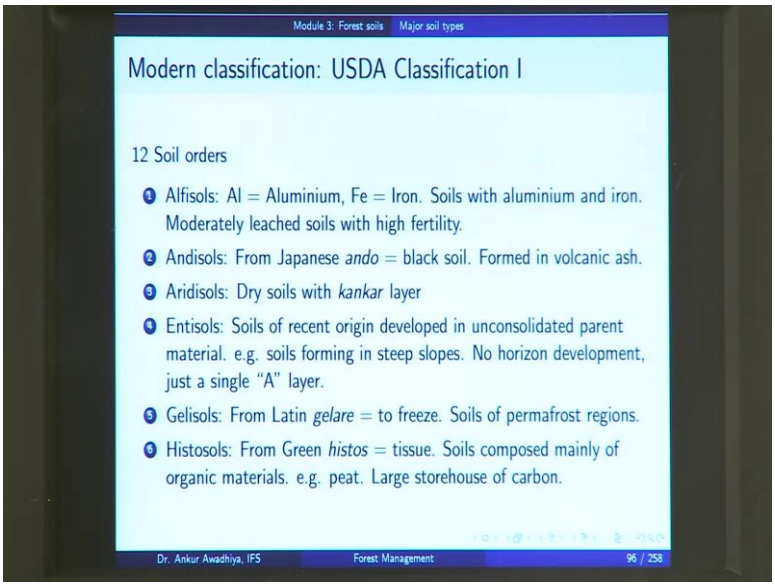

Now, this was one classification. Another modern classification is the classification by the US department of agriculture - the USDA classification. Now, in this classification, the soils are divided into 12 soil orders, and we will have a look at these soil orders. So, the first order is Alfisol, Al is aluminium, Fe is iron. So, these are the soils that have high aluminum and iron content. They are moderately leached soils with high fertility. Now when we talk about soils that are rich in iron and aluminium, even our red and yellow soils and our lateral soils are rich in iron compounds. But then in the case of alfisols, we have a moderate amount of leaching. So, this is because you do not have intense rainfall in these areas and so, you have a moderately leached soil and so, the fertility is high.

Andisol. So, it comes from the Japanese term 'ando,' which means black soil. So, andisol is the sol is the soil that is found out of volcanic ash. It is black in colour, and it is a very nascent soil.

Next, you have Aridsiols. Again, arid is dry weather. So, aridisol is a soil that is a dry soil, and as we have seen before it will be having a kankar layer.

Entisol. Entisol is a soil of recent origin developed in unconsolidated parent material, and a good example is the soils that are forming in steep slopes. You do not have any horizon development, just a single "A" layer. Now, if you remember a layer is the top soil layer in the soil or in the soil profile the soil horizons are named as O as the organic layer, A is

the top soil, B is the subsoil, C is the subscript and R is the bedrock. Now, these soils only have an "A" layer which means that they do not have organic materials in them.

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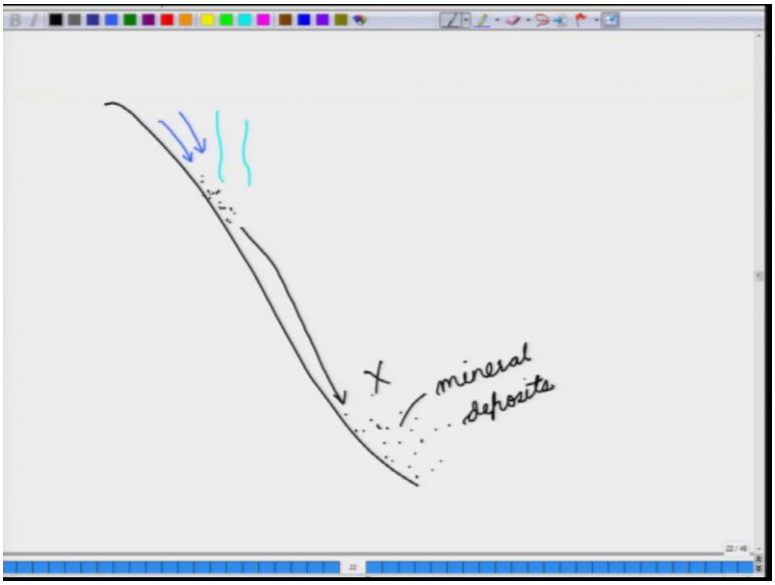

Now, these soils are found in steep slopes. So, when you have any amount of weathering, then probably because of the action of water or because of the action of winds, these soils and also because of the action of gravity, these soils come down here, and then they get deposited. Now in this weathering like situation, you only have the mineral matters. So, you have the mineral deposits. These are recently formed. these have not moved with any other area; you do not find any trees on them and so, the organic layer is not developed. So, you do not have an O layer, you only have a single A layer. There is no horizon development, and these are the soils of recent origin developed in unconsolidated parent material. So, in these soils you do not have any water that is consolidating these into a more denser aggregate.

Next you have Gelisols. It comes from the word from the Latin word gelare which means 'to freeze.' So, these are soils that are found in the permafrost regions. Permafrost regions are those regions that are permanently frozen. So, you will find them in the upper regions of mountains, or you will find them towards the poles. Now, these gelisols they typically will be having very little microbial activity, very little amount of organic activity. Because of the low temperatures, there is hardly any growth of materials, and these soils typically remain frozen.

Next, you have Histosols. It comes from the Greek 'histos' which means 'tissue,' which means that we are talking about an organic material. So, these are soils that are composed mainly of organic materials, example is peat. So, we saw peaty soils before, and these peaty soil soils in the USDA classification are known as histosols, and because you have a huge amount of organic material. So, this is also a good storehouse of carbon.

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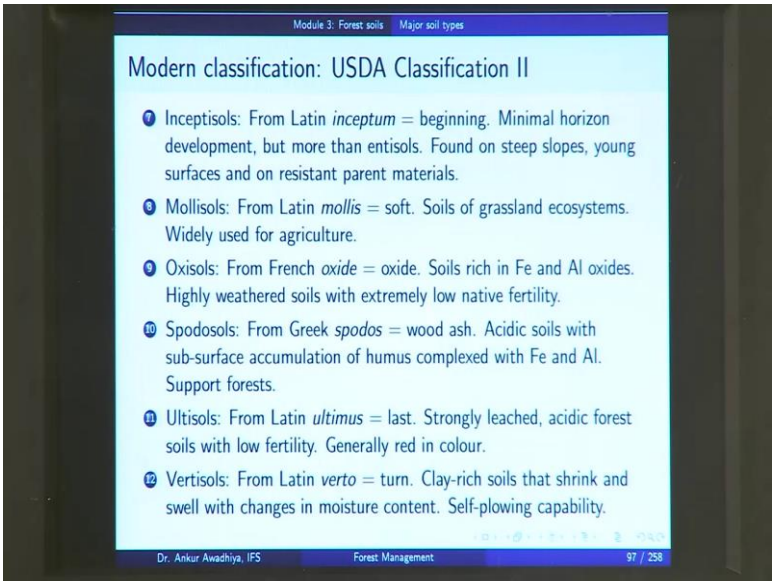

Next you have Inceptisols. Nown inceptisol comes from the Latin word 'inceptum,' which means 'beginning.' So, these are again soils that are not very much developed; these are at a beginning or a nascent stage. They have minimal horizon development, but more than antisols. They are found on steep slopes, young surfaces and on resistant parent materials.

So, these are very similar to the Antisols. But in the case of antisols, you did not have any horizon development. In this case, you have some amount of horizon development that is the only difference. They are also found in the steep slopes or young surfaces and on resistant parent materials. So, if you have a parent material that is very hard, so in that case weathering will take a huge amount of time, and this small amount of weathering that has happened in these soils that will now that has happened in these rocks will lead to the development of a very nascent soil, and that will also be known as the inceptisol.

Next we have Mollisols. Mollisols comes from the Latin word 'mollis,' which means 'soft,' and these are soils of the grassland ecosystems, and these are widely used in

agriculture. So, the mollisols, you can think about the alluvial soils, which are soft and which are fertile, now these soils - mollisols, they are the grassland soils. Now, grass as we know a when we talk about our staple foods, whether we talk about rice or wheat, all of these are belong to the grass family, Poaceae. So, a soil that can support grasses will also be able to support these staple crops, because of which most of these soils have been converted in for agricultural uses. So, the mollisols have largely been used for agriculture, because they are the soils of the grassland ecosystems.

Next, we have Oxisols, which comes from the French word 'oxide,' it means an oxide. These are soils that are rich in iron and aluminium oxides, and these are highly weathered soils with extremely low native fertility. So, here we are talking about those soils that are having iron and aluminium in the in the form of oxides, these are heavily leached soils, and they have less fertility. So, you can very easily correlate it with the laterite soils that we saw in the Indian classification. So, they are known as oxisols.

Next you have Spodosols, which comes from the Greek word 'spodos,' which means 'wood ash.' Now, these soils are acidic soils with subsurface accumulation of humus complex with iron and aluminium, and these support forests. Now spodosols, because it comes from the word wood ash; so, typically you can see that that these will form in areas that already have forests. Now, because you have forests, you will have an accumulation of humus, and typically this humus will be there on the sub-surface complexed with iron and aluminium, which means that you are having some amount of eluviation in these soils.

Next, we have Ultisols. It comes from the Latin word 'ultimus,' which means 'lost.' So, this is a soil at a very last stage. So, this is strongly leached acidic forest soil with low fertility, and it is generally red in colour. So, ultisols because it is the last soil; so, everything that was there has already been leached out. There is hardly any fertility that is left because there are hardly any minerals or hardly any fertilizing minerals that are left. All of these have been leached out, these soils are acidic forest soils with low fertility generally red in colour, because again here iron and aluminium oxides will be prevalent.

Next, we have Vertisols. So, it comes from the Latin word 'verto,' which means 'to turn.' So, these are the soils that turn themselves. They are clay rich soils that shrink and

swell with changes in the moisture content, and have self-ploughing capability. So, in the Indian classification, we refer to them as the black cotton soils or the rigueur soils.

So, in this lecture, we saw why a classification of soils is important. We began with the classification of soils, and we said that classification of soil is important for two purposes. One, you have an idea of what species can be raised in any particular site. Two, you have an idea of what was the what was the historical condition in that particular site? What was the climate? What was the topography? What are the parent materials out of which these soils have been formed? At the same time, you can make a number of deductions about the qualities of these soils.

So, for instance, if you have a soil that you see that it is a black cotton soil, so, as soon as you see that it is a black cotton soil, you can make an inference; a rainy season, then this soil will become very sticky. Whereas, when it is the summer season, and then this soil we will be having a number of cracks in it. With this information, suppose you want to have your silvicultural operations, or you want to raise a forest plantation in this soil; so, what will you do?

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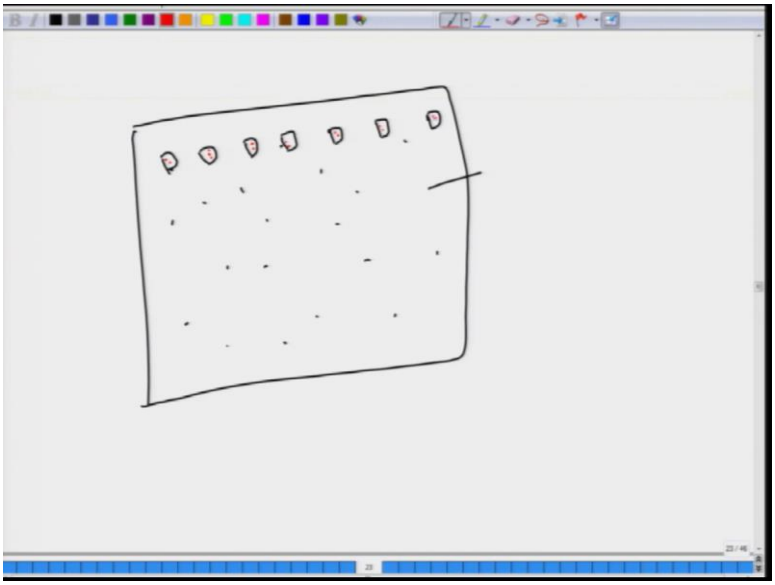

When you have this area, and this area has black cotton soil. Now, the question is when are you going to dig your pits, can you dig your pits in the rainy season? The answer is no, because as soon as you have the first rains, these soils will swell and they will become extremely sticky, and they will be so sticky that it will be next to impossible to

dig holes in these soils. These soils will stick to the boots. These soils will stick to the implements. They will stick to a anything and everything.

So, if you want to dig pits, these pits should be dug in the summer season. So, these pits will be dug in the summer season. Similarly, if you have a soil say if you have a lot of sandy soil in your area, now if you want to raise any plantations. So, can you raise a plantation in the desert soil or a sandy soil? So, the answer is yes, because you know that there will be kankar nodules at the bottom, at you might even go for a few sampling in a few locations, but then because you know that there is an impermeable layer of kankar nodules; so, you can actually raise plantations in those areas.

Similarly, if you have a region where you see that it has laterite soils. So, because a laterite soil is heavily leached; so, probably you will say that if I need to raise a plantation in this area, I will need to supplement this soil with some nutrients. So, when you are digging your pits here, you will also be adding fertilizers into it.

If you have an alluvial soil, then you will say that this area has enough amount of water, or it is there in a delta area, or it is in the river valleys, the soil is soft. I can very easily dig holes, but you know that because the soil is rich in clay, then probably the soil will also be prone to erosion. So, in that case, you will you will perform your pit digging operations in a way that you are able to reduce the amount of erosion that can be there in this area. Or for the same matter, because you know that it is a clay soil, it will not allow water to get inside, probably you would also think about making some water harvesting sites in these areas.

So, these are the kinds of inferences that you can make that will be useful, when you are raising the forest drops. So, we looked at different kinds of classifications. We looked at the earliest classifications, which just talked about whether a soil is fertile or whether it is infertile. So, a fertile soil is in urvara soil; an infertile soil is an usara soil. Then, there was a classification that was based on texture - is it a clay soil, is it a sandy soil, is it a loamy soil, is it a silty soil and so on.

Then, one other early classification was on the basis of the colour. So, whether it is a red soil, it is a black soil and so on, but then these early classifications gave you little information - about the characteristics, about the genesis, about the composition of these soils. So with time, we move to the modern classifications, and we looked at 2

classifications one was the Indian classification; the second is the USDA classification by the US department of agriculture.

Now, in the Indian classification, we saw things like the alluvial soil, the sandy the arid soils, the saline soils, the black cotton soil, the laterite soil, the red and yellow soil, the forest soil, and so on. And in the case of the USDA classification, we have 12 different soil orders everything ends with a sol, and most of the terms are derived from either Latin, Greek, Japanese or French words. So, once you know the name of a soil, you can make inferences about how this soil was formed, and what are the properties, and that will be useful in making managerial decisions. So, that is all for today.

Thank you for your attention [FL].