Irrigation and Drainage
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Lecture - 41
Drainage System Components

Hi, this is a lecture number 41 so, on Drainage System Components.

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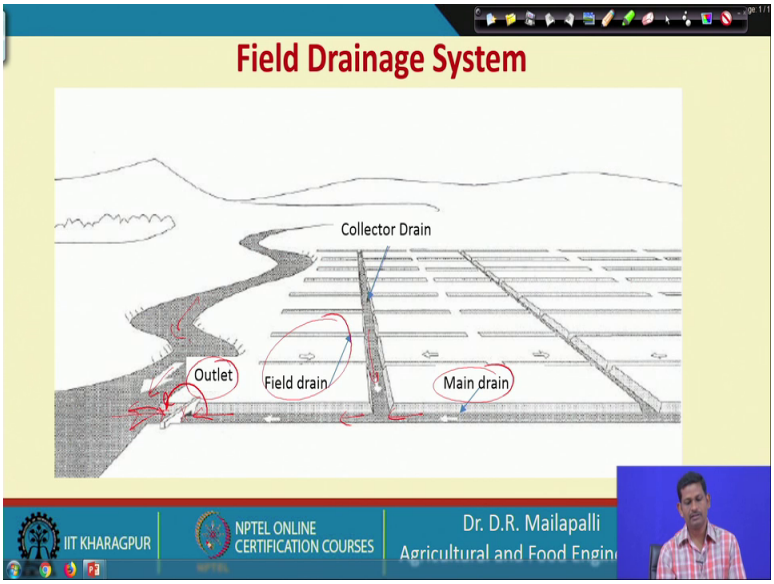

So, in the last class we have initiated the, I mean drainage systems and their components. So, we are going to stretch little bit forward on the same issue. So, here the field drainage system if you recollect from the previous lecture; so, it has a collector drain or you can say this is the field drain. So, the from field drains so, these are the laterals in the field which collects the I mean excess water on the surface to the collected drain right.

And from the collected drain, so, all the collected drains lead to the water towards or a inside the main drain. This is the main drain and the main drain is going to you know convey the water towards the outlet here right. So, the from outlet in goes to the nearest stream or any watercourse. So, here outlet can be like a gravity outlet and pump outlet.

So, if the level, the base of the you know main drain is higher than the base of the watercourse, then the gravity outlet will work. If suppose the base of the main drain right, say lower than the water level of the watercourse. So, then there is a chance of

water which is coming from watercourse to the main drain and the drain may not be working. So, in that case we have another pump outlet so, we are going to close this right and then we have to close this outlet and pump this water to the watercourse.

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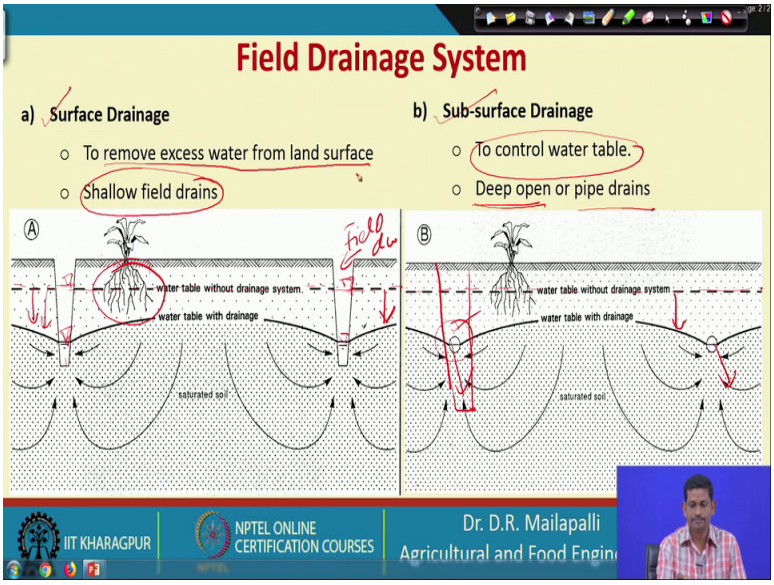

So, then so, as I mentioned we have a surface drainage system and subsurface drainage system. So, the main goal of surface drainage system is to remove excess water from the land surface by using shallow drains. So, here if you see in the picture so, for example, so, this is initial water table right. This is initial water table of drainage system and you would like to you know pull this water table below the root zone because, this is the root zone. So, in order to do that, so we going to construct the shallow drain field drain these are the field drains field drains and cross sectional view.

So, then what happens? So, since initially the water level probably could be here because of the water table. So, then when the field channels you know withdraws water towards the main channel. So, then the water table is going to a down to the, I mean the next water table will be going here. So, that it is just below the I mean the water table is below the crop root zone and this is what we are expecting from the surface drainage and whereas, subsurface drainage. So, this is basically to control water from the to control the water table in the root zone and also to the control the salt content.

So, mostly we use the is deep open ditches or pipe drains are going to be used here the example of pipe drains. So, here the initial water table and when you use the pipes to

drain the water out right. So, then this water table is going to fall here. So, since so, here either it can be like a deep ditches right, either it can be deep ditches or like tiles.

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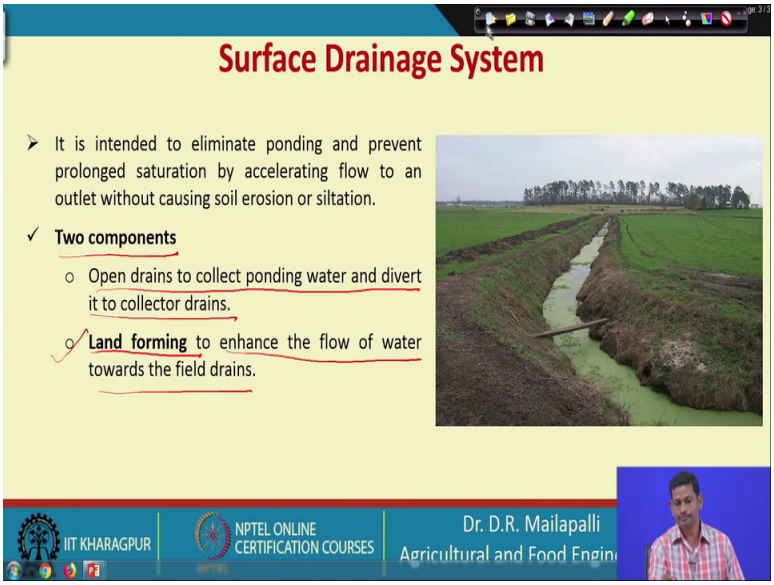

And then, here surface drainage system. So, if you focus on the surface drainage system, so the basically it has 2 components right. So, one is open drains to collect ponding water and divert it to collector drains. So, that is we have seen. So, first it collects the water from the field drains. So, or open drains and then and then convey this to the main drain.

And other thing other important thing is the land forming. So, this is very important in case of surface drainage system. So, this will enhance the flow of water towards the field drains. So, what happens if we have the terrain or the land surface is not properly you know levelled? Then, land farming is very important in order to convey the water easily to the shallows, I mean channels or open ditches. So, then what are the land farmings?

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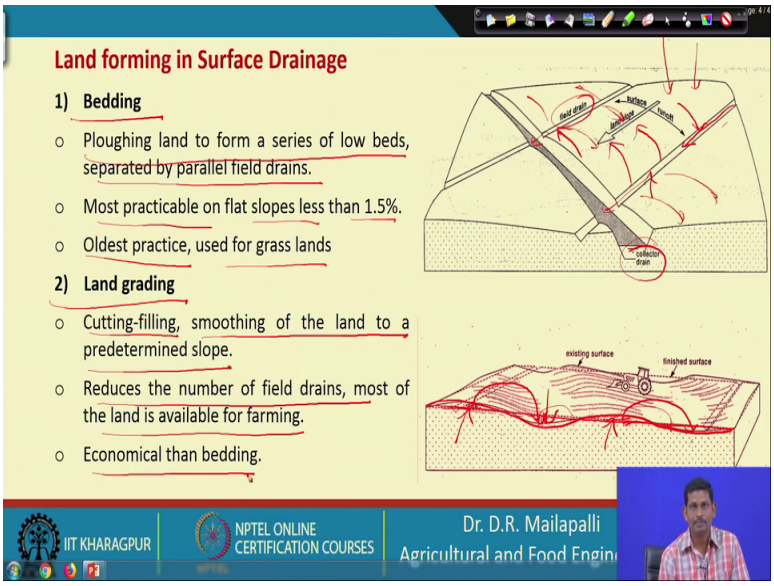

So, we are going to see the types of land forming we follow in surface surface drainage system. So, one such land forming practice is the bedding. So, the bedding suppose you have land surface like this in bedding, what happens? So, you are going to bed the soil right from the channel to the other channel.

So, in between; so, just a kind of a shallow heap right like this is another heap. So, that what happens if there is a water which is which is falling on the surface. So, that will be you know runoff to the you know the shallow channel a open ditch and finally, it goes to the collector ditch the similarly here. So, water is going to runoff to the nearest field drain and then runoff to the collector drain. So, this will help basically so, the bedding will this kind of a ploughing land to form a series of low beds are separated by parallel you know the field drains right.

And then, most practicable on flat slopes less than 1.5 percent because the flat slopes. What happens if you have flat slopes? The water which is falling or the rainfall which is falling on the surface will be undulated like will be causing ponding. So, that is we need to make a bedding. So, that the water can easily runoff from top to the nearest field drain.

And this is the oldest practice used for grasslands mostly and other practice is called land grading. So, in the land grading so, what happens if you have undulated rain or undulated surface. So, suppose this is initial the land condition right, if this is the initial land condition and you want to make a grade right the slope like this right; this is the design

slopes you are going to make a slope like this. So, for that the method is called cut and fill.

So, wherever there is you know heap or extra soil that will be cut and wherever it is required for example, here you need to fill it. So, cut this portion and fill it here. So, this is called cut and fill method and after that this will be you know you know levelled and finally, the land grading is required land grading is taking place.

So, basically the cutting and filling then smoothing of the land to a predetermined slope. so, is knowing the slope you are going to see how much soil needs to be cut here right and how much needs to be cut here. So, that this will be filled and it reduces the number of field drains most of the land is available for farming. So, in this case in the bedding case what happens because of the because of the field channels closer or number of field channels number of field channels the forming operations will be a little difficult.

So, here the field channels are fewer, I mean it is less compared to the bedding case and you have more favourable forming operations and economical than the bedding. Because the number of you know field drains are less in this case.

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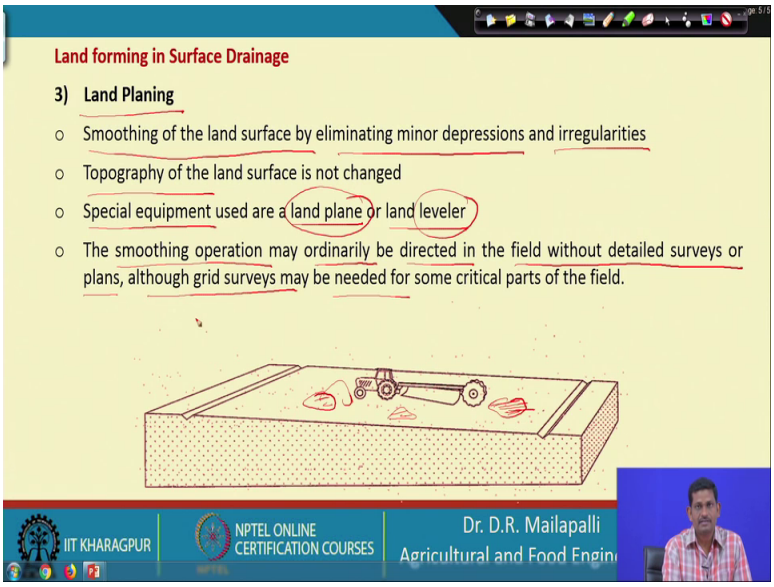

And then, next third operation could be the land planing. So, this is the land planing. So, this is basically if you have a flat surface or I mean a well graded surface, but still there are some patches in between. So, suppose you have a patch here and the patch here may

be hill here. So, in that case what happens? So, we use a like a land plane or land leveler will be used to fill up you know. So, this patches by using nearest you know hills or maybe some soil from other you know other places so, this can be levelled there.

So, this is called of a smoothing or land surface by eliminating minor depressions or irregularities on the surface and topography of the land surface is not changed because for do I mean in doing that here we are not going to change any a land slope, only thing we need to correct the land slope by adjusting the I mean cuts and fills or depressions.

This is a special equipment like a land plane or leveller will be used and the smoothing operation may be ordinarily be directed in the field without detailed survey or plans, although grid survey may be needed for some critical parts of the field. Suppose if you have a the field with you know a lot of patches or maybe you know 20 at least 10 to 15 percentage of land is under you know depressions. So, then probably you may have to you know plan for little I mean land grading. So, for in that case you know the grid wise survey may be required.

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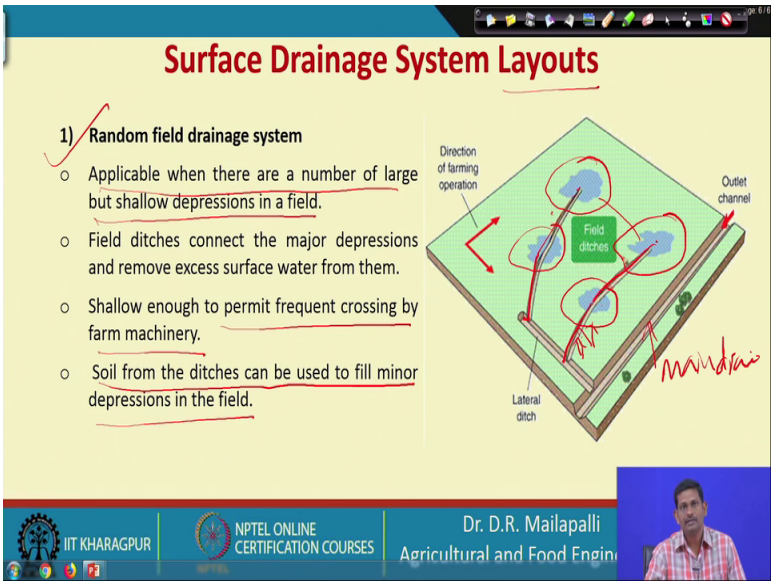

So that is all for the surface drainage system right so, those things are very much required like a one is bedding you know and then grading and planing. So, these things are required in order to convey the water I mean water which is falling on the surface to the nearest field channels right. So, this is conveying in order to ease the conveyance. So, then so, after that, so, what are the types of these field channels? So, types of field

channels are layouts if you see the layouts. So, the first could be the random field drainage system. So, in this random field the name indicates the random field drainage system.

So, if you have a like the patches like for example, here there is a depression and here there is a depression here there is depression a depressions where the water which is falling on the surface is causing inundation. And if you if you have too much water, then this and this going to you know you know merge and that can increase the you know inundation area. So, for that what happens the random field drainage system connects the patches like from here to here and from here to the main field channels right.

And similarly, this depression and this depression and finally, connected to the collector drain. This is these are the field channels or field drains field ditches and laterals or collector drains and finally, this is the main drain. So, basically the application when there is a number of large and shallow depressions in the field and that is what I explained and field ditches connect the major depressions. So, these are the field ditches right.

So, they connects the major depressions and finally, leads to the collected drain shallow enough to permit frequent crossing by farm machinery. So, a this is the problem because these are the shallow so farm machinery farm machinery equipments can cross right It can cross and do the operations easy.

So, and soil from ditches can be used to fill minor depressions in the field. So, from the ditches. So, when you make the ditches. So, sometimes what happen in order to construct these ditches and you have to remove some, I mean soil that soil can be filled to the you know some of the depressions. So, the next one is the random a field drainage.

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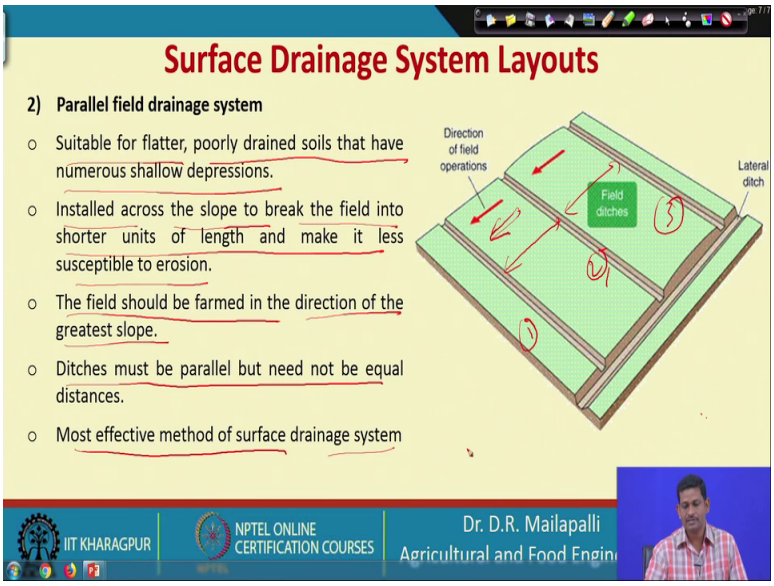

And the other one is the parallel field drainage system in the name indicates the parallel field drainage system. So, here the field ditches are parallel to each other right. So, this is the let us say 1 2 and 3. So, these are the ditches so, field ditches they are they are parallel to each other and the distance between the ditches may varied; it may not be constant, but only thing is they need to be parallel; they need to be parallel.

And this is suitable for flatter and poorly drained soils that have numerous shallow depressions if you have large number of shallow depressions right. So, and these parallel drainage system would help in you know removing the excess water from the surface. And instead sorry installed across the slope to break the field into shorter units of length and make it less susceptible to erosion. So, in this case the erosion sometimes would be a problem.

So, this field ditches needs to be a constructed across the slope. So, that the erosion can be reduced or minimised, the field should be formed in the direction of the greatest slope this is another recommendation. So, look for the greatest slope and you are going to form the land towards the greatest slope.

And ditches must be parallel, but need not be equal distances as already mentioned the most effective method for a surface drainage system. So, this is this is the most effective compared to your random layout. So, the parallel field drainage system is more effective drainage system.

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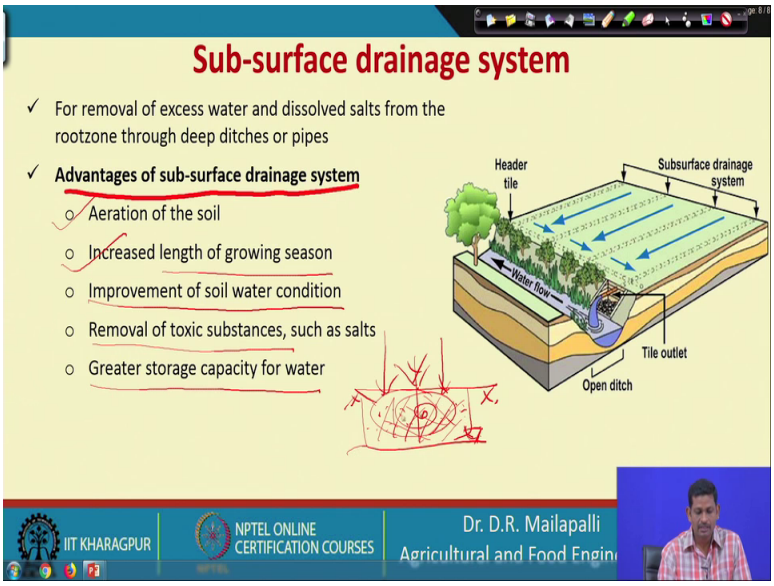

And the other one is the sub surface drainage system. So, in sub surface drainage systems as the name indicates. So, we going to collect the water both from the surface as well as the root zone a since we are interested in the irrigation, I mean growing crops. So, our interest is to remove excess water from the root zone. At the same time, the subsurface drainage will also remove the salts.

So, and then what are the advantage of you know subsurface drainage system? So, the advantage are first thing is aeration of the soil right. So, once you are removing once we are removing you know excess water from the root zone right from the root zone. So, that means, this is all become unsaturated flow conditions; that means, so, where is a at there is a I mean soil pores which have filled with air.

So, that air is very much important for roots to be respirated so, then increased length of growing seasons since this drainage system will help in removing the excess water in the monsoons season or in the beginning of the monsoon as we expect lot of water in the beginning.

So, our sowing date would be faster like early so, sowing it can be possible. So, that way the length of growing season would not help in would not affect in you know the crop growth and then improvement of soil water conditions. So, since this is under aerated condition right, it is not aerated right. So, the forming operations can be easily done on this on this on this lands and then remove toxic substances such as salts. So, that is one

of the you know objectives of I mean subsurface drainage system. So, and greater storage capacity of the soil. so, of the water and capacity for water right.

So, since the water is been removed and the unsaturated condition is achieved. So, the excess water so, the additional water which is falling can be stored inside the root zone. So, that will improve the storage capacity of the soil.

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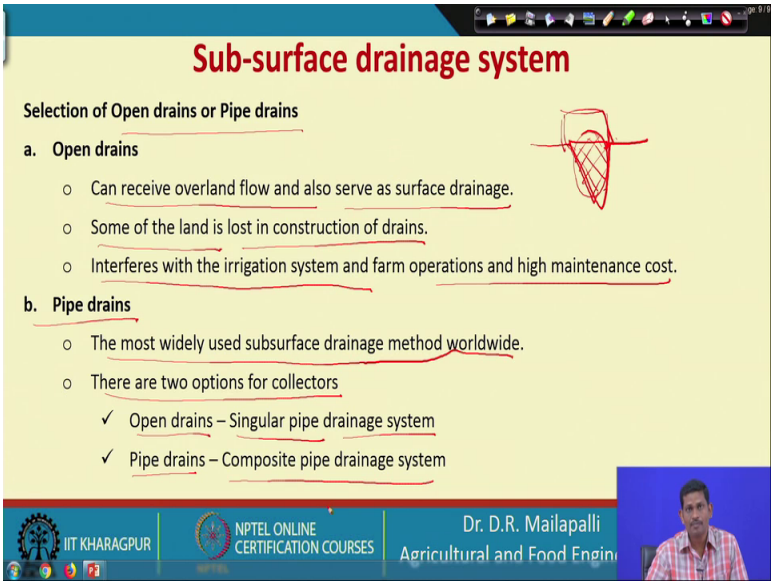

So, the next is so, how the selection between you know the open drain and pipe drainage system. So, the open drains open drains what happen? It can receive overland flow and also survive the surface drainage. So, that is what the open drainage basically to remove excess water which is ponding on the surface and some of the land is lost in construction of drain. So, compared to subsurface drainage in except in case of you know deep ditches.

So, the surface drainage system is going to lose a soil or extra you know because for making ditches you need to remove the soil and this much area is not used for any cultivation. So, you are losing farm land.

And interferes with the irrigation system farming operations once there is a gap right or depression due to so farming operations cannot be you know is it is difficult to operate the farming equipments on the field. So, and then the pipe drains the most widely used subsurface drainage method worldwide. So, that is why, in case of pipe drains what

happens? You may not be seeing the pipes you know over the surface it is underneath the surface and. So, that will really help in you know farming operations so easy.

And then and also you are not going to lose any farming a farmland. So, there are 2 options in collectors. So, open drains. So, it could be like a singular pipe drainage system or the pipe drains the composite pipe drainage system these 2 options of collectors can be possible in case of pipe drainage system. We are going to see what are the singular and what are the composite pipe drainage system. If you see this, let us see.

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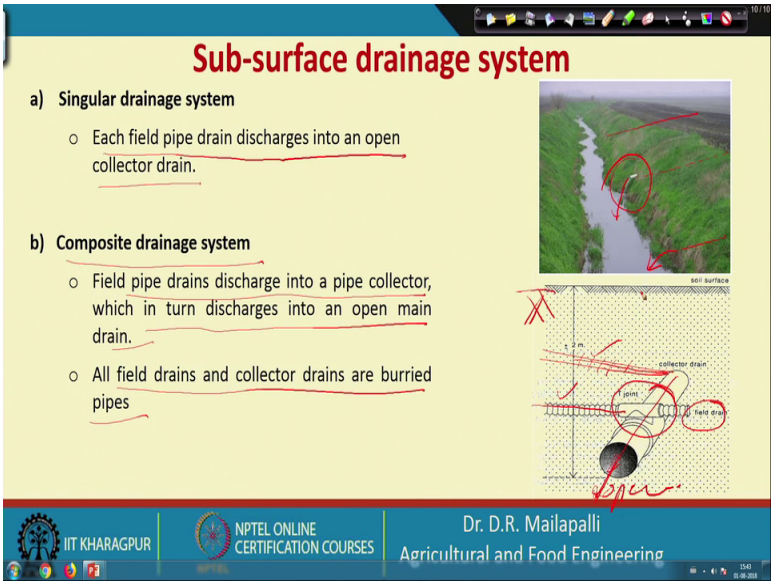

So, here the singular systems or such that each field pipe drain discharges into an open collector drain if you see in this picture. So, the pipe drains are going into the soil right, but. So, all these pipe drains here also there is a pipe drain and here, also there is a pipe drain so, all these pipe drains are going to yield water are like this for example, here.

So, water is really coming into the open ditch here so; that means, the pipe drain or the tiles are open to the tiles are open to the you know main drain or field ditches in this case or collectors right. Whereas, composite drainage system what happens. So, here these are the pipes just like this right. So, these pipes are installed underneath the underneath the ground surface right.

And there is a collector, the collector which collects which collects the water from you know drainage from all the fields all the, I mean the field drains here is the tiles, from all

the tiles and then removes the water. So, like here you are using a T joint right the T joint. So, this is kind of a composite. So, a composite in the sense collecting drainage from all the you know the tiles through a single pipeline.

So, here the field pipe drains discharge into a pipe collector which in turn discharges into a open drain. So, right from here, this will be in open drain. So, all pipe drains and collector drains are buried pipes in this case. So, here this is open and this is these are the buried.

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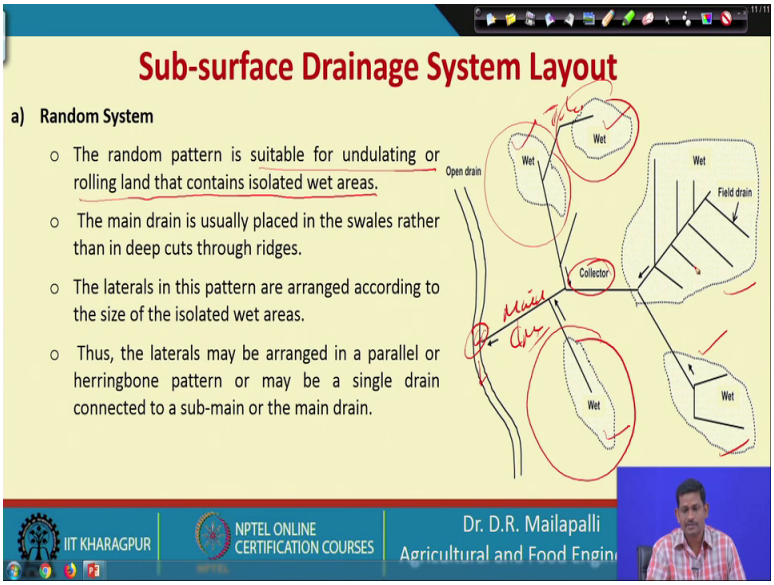

And then in sub surface drainage system also if you see the layout similar to in case of surface system you have 2 kinds of layouts one is random field drainage and the other one is parallel you know field drainage system. So, similarly here the random system so, random system here the pattern is suitable for undulating or rolling land contains isolated wet areas. Similar to your surface system, in case of sub surface system also you are going to connect the depressions randomly developed depressions here. For example, here is a wet spot right here is a wet spot and here is a wet spot, wet spot, wet spots so, right.

So, all these wet spots are collected with field like tile drains right tile drains. So, the tile drains are these are you know a underneath the ground. That is why, this is sub surface drainage system and then you are going to collect water from I mean drainage from a

different patches right. And then finally, to the main channel or water course and this is the main channel right. This is the main drainage system drainage pipe or tile pipe.

And within the suppose if the area of depression is larger, if area of depression is you know large, then you can also plan for a like we are going to see the other type of a you know drainage systems, for example, parallel drainage system and then Herringbone systems. So, those can be you know planned for each depressions here. So, so within the random system we are going to see the other drainage layouts. So, we are going to see those.

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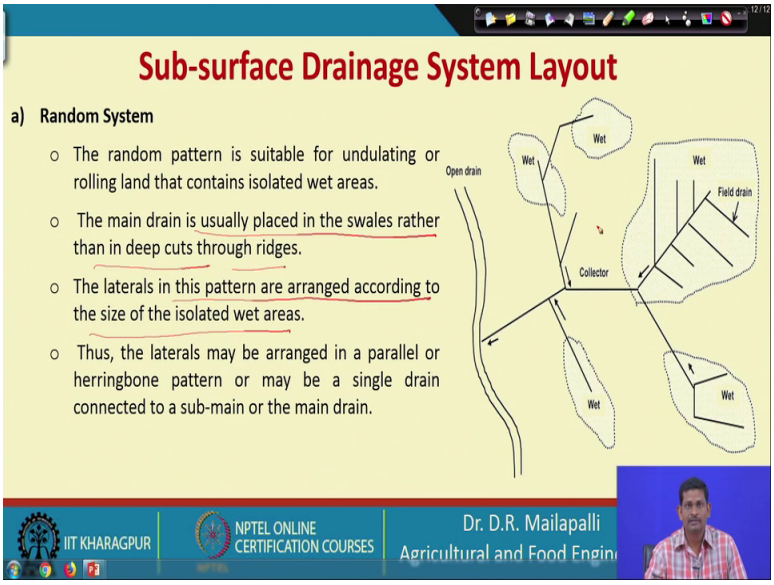

So, here the main drainage; the main drain is usually placed in the swales a rather than a deep cuts through the ridges right. And then the laterals in the pattern are arranged according to the size of the isolated wet areas. Suppose, if you have the isolated wet areas or smaller right small areas as I mentioned. So, or bigger areas you can go for other drainage layouts. So, let us see the other layouts which can be in a adopted in a random system. So, the other one is similar to your surface system surface drainage system.

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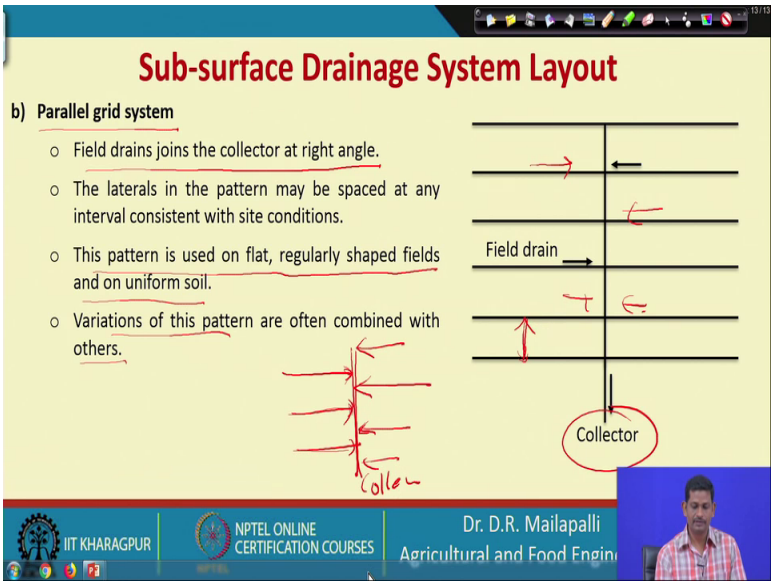

There is a parallel grid system. So, here the parallel also we are talking about that tiles installed within the ground right in, but they are parallel to each other. The field drains joins collector at a right angle if you see this. So, this is the collector right and these are the field drains right, these are the field drains. So, and in the laterals in the pattern maybe spaced at interval consistent with their site condition. So, here I mean these laterals sometimes what happen? So, the spacing could be, I mean the same spacing sometimes you may have to change.

Spacing you know based on the terrene of the soil. So, this pattern is used on flat regularly slope fields and uniform soils right and variations this pattern are often combined with others. So, this can be combined. So, this can be sometimes what happened one sided and multi sided also. So, suppose you have the collector here right. So, sometimes what happens so, these this parallel drains could result you know could drain to the collector in one side right, this is one side. So, sometimes what happen? So, you may you may also see in the double sided. So, single side drainage system and double sided also right. So, this kind of system can be I mean can be observed in parallel drain system. So, then the third one is the Herringbone system right.

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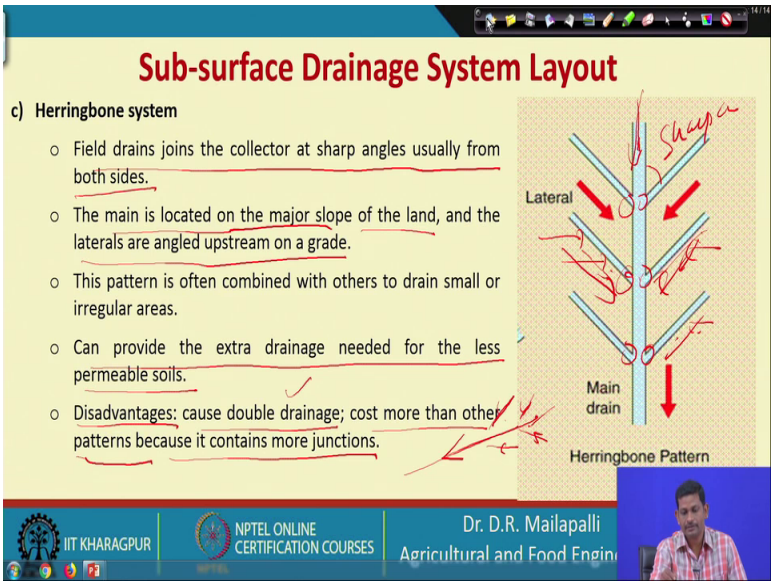

So, Herringbone system. So, in parallel system what happens the field ditches or parallel to sorry perpendicular to the collector, but here the field or you can see the lateral or field ditches or you can be tiles field tile drains right. So, they have a sharp angle, these are the sharp angles with the collector. So, that is the different kind of Herringbone in the right, say bone kind of thing.

So, field drains joins the collector sharp angles usually from both sides right from the side and this side and the main is located on the measure slope of the land right; that is the main and the lateral soil angled upstream on a grade. So, these are the upstream in this is the main drainage located in the in the major slope right. So, suppose that the field is sloping this side right, sloping this side is the main drain goes into the this slope where as the other things right the cross slopes. So, those are the across the slope.

It can provide the extra drainage needed for the less permeable soils. So, if you are using you know sandy loam soils or the clay soils. So, is this can provide extra drainage needed for the less permeable soils. So, and disadvantages kind of cause double drainage right and cost more than the more than other patterns like you have random and parallel or because it contains more junctions. So, because so, I here you have a junction here junction right. So many junctions are involved in case of Herringbone, the cost is more right compared to other drainage layouts and it causes the double drainage; it causes the double drainage sometimes.

So, that is why Herringbone is kind of you know when you design it should be designed properly so, what happens when double drainage in the sense. So, here there is a drainage which is also take place and maintenance and also you have the costs slopes that can lead to the extra drainage here.

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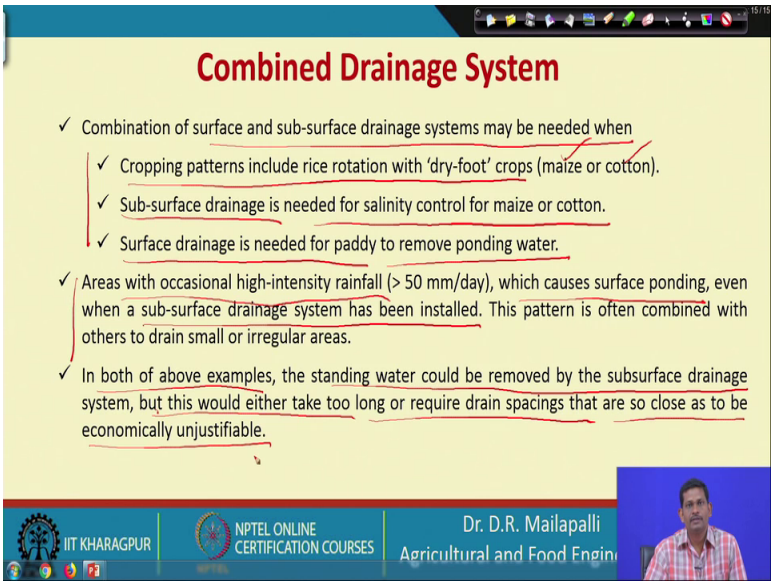

So, then So, sometimes you may also see the combined drainage system where this is basically depends on the different cropping patterns. So, looking for different cropping patterns for example, paddy right; paddy is a it requires lot of water right standing water compared to in the same season. If you are looking for maize right cotton right all the things. So, those things those crops does not require much water right.

So, in that case, in order to balance or in order to I mean give water properly to the particular crop you may have to use combined drainage system. So, in case of combined drainage system what happened? The surface and subsurface drainage systems may be needed right when cropping patterns include rice rotation with dry foot crops such as maize or cotton. So, these are dry foot crops is not here because, I mean it requires you know aeration compared to paddy and subsurface drainage is needed for salinity control for maize or cotton sometimes. If you are growing maize and cotton in case of you know saline soils.

So, you may have to use leach ate water to drain out right you need to. So, there subsurface drainage is required and surface drainage is needed for paddy to remove

ponding water. So, sometimes if the excess water is too much on the paddy like surface. Generally, for paddy it is like 5 centimetre standing water is practised or 5 to 10 centimetre. So, if the water is more than depth, you need to remove it using surface drainage system right.

So, these things can be if you are having this kind of situation you may have to use combined drainage system. That means both surface and subsurface drainage system. So, the areas with occasional high intensity rainfall for example, 50 mm per day I mean more than 50 mm per day. So, which causes surface ponding right and even when a subsurface drainage system has been installed.

So, even if you have subsurface drainage system right when the areas with high intensity rainfall. So, that may definitely cause surface ponding because such a high intensity rainfall cannot be accommodated in you know subsurface drainage system.

So, that for that conditions, you may have to use surface both surface as well as subsurface drainage systems. In both of the above example for example, here one is cropping pattern and rainfall right in both cases the standing water could be removed by subsurface drainage system right. But this would be either take too long or required drain spacing that are close to be economically unjustifiable.

In both cases, both I mean different cropping pattern you are planning right and also in case of high intensity rainfall right. In both cases I mean keeping the subsurface drainage system definitely will help, but the thing is this is not fast enough to drain the water in cases. So, you need to use both surface as subsurface drainage systems.

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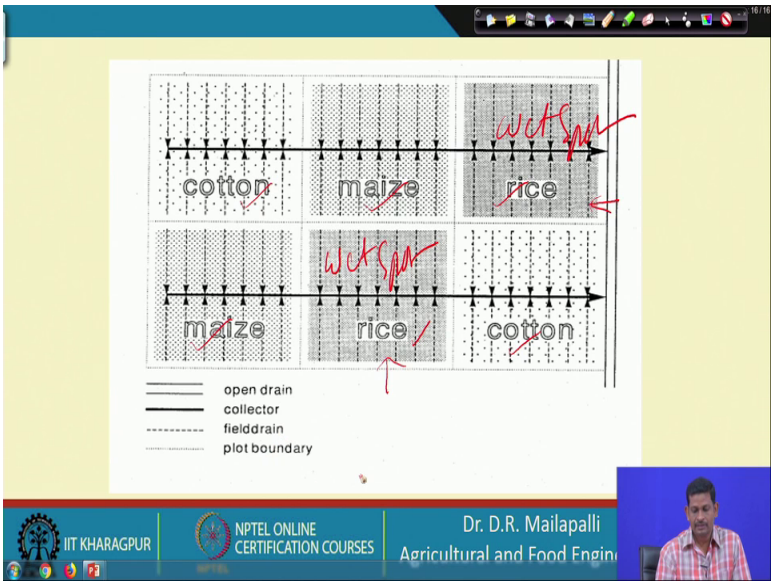

So, here this picture can really tell how the both I mean combined drainage system can be used in case of different cropping patterns for example, so, this is a dry foot crop this is cotton and maize and similarly the rice. So, these and another plot has maize and the rice and cotton. So, here the rice, this is a wet spot right; this is a wet spot and similarly this is a wet spot and others are dry spots dry spots in the sense it requires you know not standing water, it is it does not require any standing water.

So, if suppose see the water is too much. So, water is too much in the sense if you are planning this and the high rainfall intensity is taking place. So, what happens for this the dry spot it i. so, the water can be you know removed by subsurface drainage system, but whereas, the rice case. So, it is already you know there is a standing water and the excess water cannot be you know drained out and you may you have to use surface drainage system here. So, this is what the combine drainage system used during the different cropping pattern as well as the high rainfall intensity cases.

So, with this in this whole lectures we were focusing on you know the layouts basically and different types of drainage system and their layouts. So, surface and subsurface drainage system, basically surface drainage system will be used to remove the ponding water which is you know you know standing on the surface of the ground and using the shallow ditches. So, whereas, subsurface system so, their main goal is to remove excess water from the root zone as well as the salts from the root zone.

So, these 2 objectives will be done by subsurface drainage system. So, you can either use deep ditches or tiles or tile pipes pipe drainage system. So, in case of surface drainage system, since I mean there is a layout different layouts are there. So, there are 2 layouts random drainage system as well as and a random field ditch system or the parallel ditch system. These 2 ways whereas, in subsurface drainage system. So, they have also random drainage system and parallel drainage system right and the third one is Herringbone drainage system.

So, in the random drainage system you may also see the parallel as well as you know Herringbone system for a particular what you call the wet spot; the wet spot is that means, the depression is you know wider or the big area. So, you may have to use either I mean either of the I mean combination of different layouts like you can also say random parallel and Herringbone system in case of subsurface drainage system.

So, in sometimes what happens you may have to use the combined systems right. For example, there are 2 cases; the case number one is if you have a different crops are grown in a particular area right. So, those or their water requirements are different for example, paddy it requires standing water whereas, other crops like maize cotton. So, they may not be requiring you know standing water right. So, in that case what happens? So, if you have large you know rainfall which is happening in short period of time.

So, I mean the and the crops which are aerated can be can be if they have you know subsurface drainage system right. But whereas, paddy crop, it is already water which is you know stagnant. All surface the excess water can really cause the water logging to the other fields also right, other fields also you may require the surface drainage in this case. So both, surface and subsurface drainage or systems can be planned some situations as I explained and.

Thank you so much. See you all.