Water management
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Lecture No 19
Irrigation Methods (Contd.)

In the last class we had looked at the furrow irrigation method and we had also mentioned that besides those 3 conventional methods which have become very popular over the last many centuries, the border irrigation, basing irrigation and the furrow irrigation. Besides these 2 methods these 3 methods there are some other methods which are variations of these methods they are also being used in some places where the situations warrant those methods should be applied either because of the constraints, the financial constraints or because of the constraints of topography or the soil types or the soil depth all those things put together they are…

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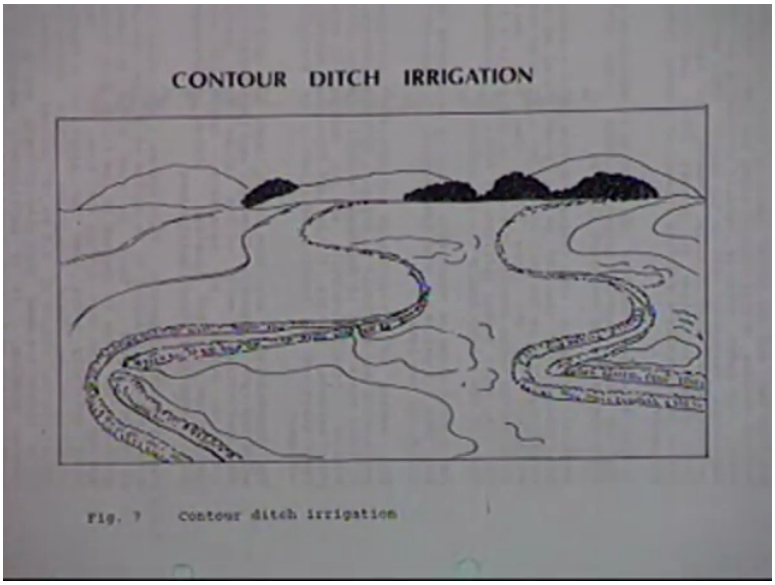

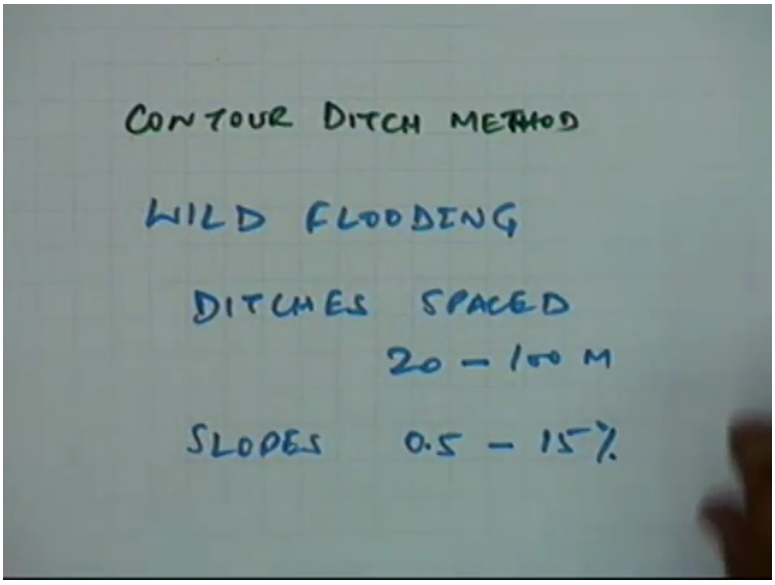

Let us discuss 2 of those methods which we had mentioned in the beginning these are contour ditch method and the other one is contour levee method. Let us first look at in the case of contour ditch what type of layout we have and what it is suitable and which type of situations. Now this is the figure of a contour ditch irrigation method, you can see here that as they are 2 ditches, this is one ditch this is another ditch, so what you have done is that you have laid the ditches, some ditches the size of the ditch can also vary depending on how much is the stream size which is possible or which you want to use. These ditches are laid on the contours and then you while irrigating the area you make the openings in the ditches and let the area be flooded, so this is basically a method of wild flooding.

This is a method of a wild flooding in which you have ditches which can be spaced about 20 to 25 metres and it may go up to 100 metres, so the spacing between the ditches can be varying between 20 to 100 metres that means the area which will be covering from this end to this end can be a wide area in case you have the infiltration rates are lower, if the infiltration rates are higher then you might restrict the width between the ditches, so that is that is up to you will have to look at any other conditions also the soil type than the slope.

The slopes in this case is again the slope variation can be quite excessive, you can use these method of contour ditch on slopes which are as low as 0.15 percent or even higher slopes but again the restriction will be that what is the slope along with the soil type which is not creating any erosion problems. The extreme size which you are going to use they are they are comparatively higher stream sizes, you are flooding the areas you can afford to use the higher stream sizes if the area are flatter areas if the areas are steeper areas you might reduce the stream size, so in this method is not basically a method which is very sophisticated method

you are using this method because of the fact that you want to make use of the existing conditions and you do not want to indulge much expense which is involved in forming the area or grading the area.

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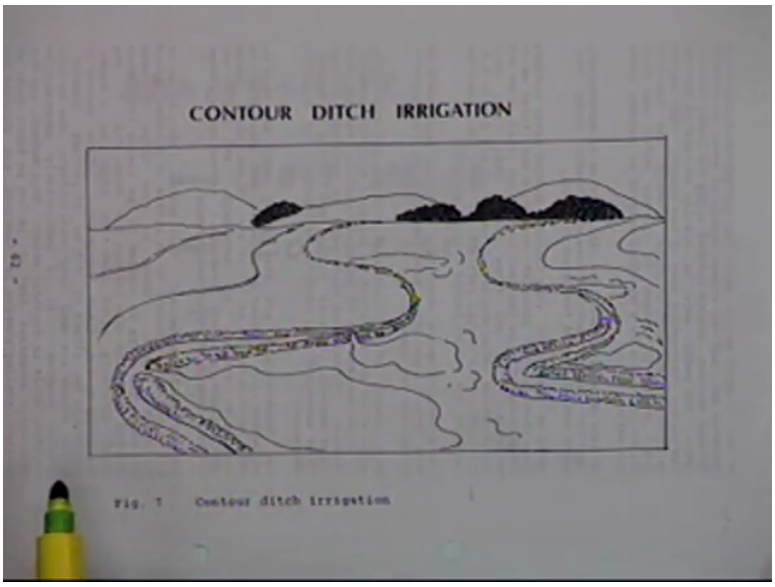

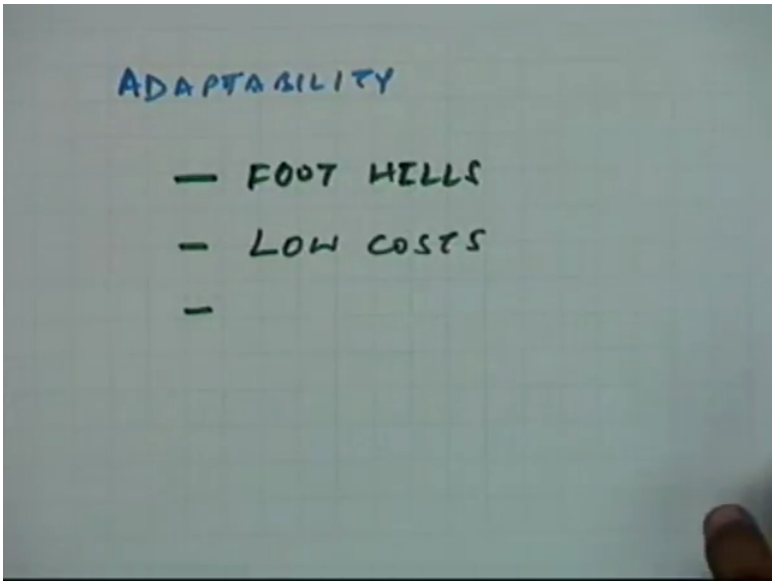

So the adaptability if you look at where these methods from the adaptability point of view you will find this method to be quite useful when you are talking in terms of foothills. Those areas which are lying on the foothills which are having slide undulations but not the slopes are not very steep but at the same time you cannot afford to from these areas or (())(6:42) these areas because of the fact that the soil depth is quite shallow, so if you try to reform this areas or you go in for the grading of these areas you will find that the soil, the fertile soil will be lost you might be having a very small depth which you cannot manipulate you cannot you

cannot grade that soil because of the loss in fertility and as such that the depth of soil available is very shallow.

Then it is involving very low cost on those accounts because you do not need any in this case there is no land grading required. The ditches are also (())(7:41) so there also you can save a lot of expenses, then the labour expenses also not very excessive because the places at which you have to make the openings there is not a very skilled thing with slight amount of experience will know that at what spacing because that will be a function of spread of the water up to which area the water can spread, so it is not a very scientific method it is only a method which may be used under some circumstances where you do not have any other possibility of using the other method because of various reasons which you have just discussed.

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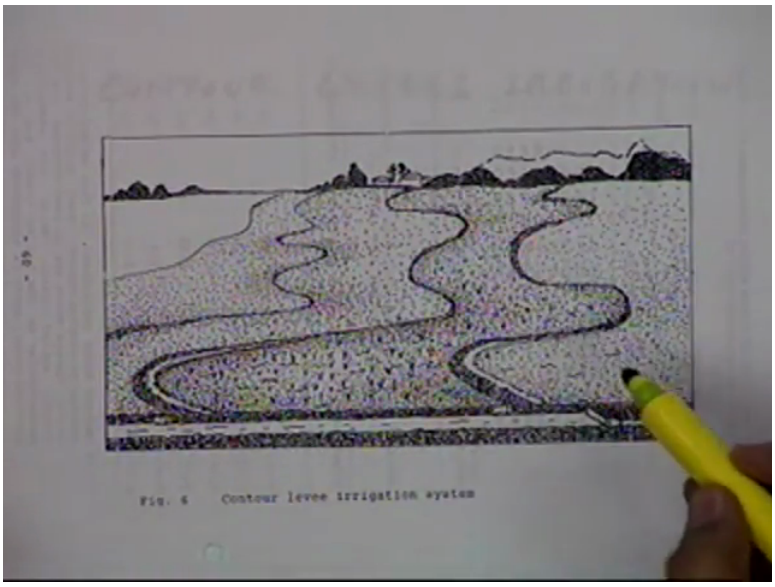

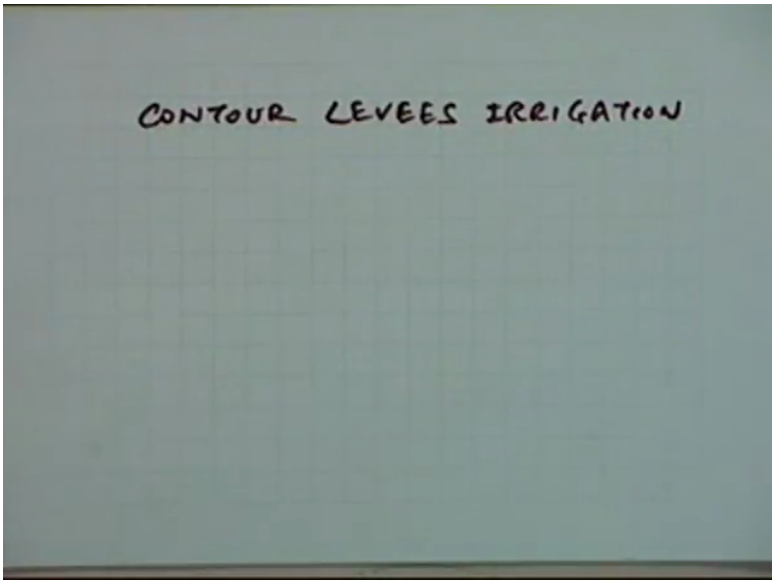

Let us quickly go down to the next method of contour levees which again is quite similar in terms of the previous method which we have discussed was in this case also you use this method where a situations or the conditions do not warrant any land grading or land shaping because of various reasons and in this method you are not using the ditches but you are using the natural slope which is available in the area, so if you look at this this is a strip this is a strip which is not a parallel strip as you have in the case of border.

In the case of border irrigation you are trying to make the strips parallel so that you can have a very uniform flow over the strip. In this case there is some, the slope may be in this direction there is a gentle slope, so you have tried to utilise that slope which is in this particular case the slope will be in this direction because you are supplying the water from some upstream end to the downstream end in this strip and this strip you have not you have tried to use the contours, these are the natural contours which might be having some downslope because unless the slope is there you might find that the water might not move in the in the lateral direction in the longitudinal direction, so you have to have some slight slope otherwise a size of the stream have to be very excessive.

If the slope are less the lesser of the slope to cover larger area you will have to have excessive stream size but that can only happen if the soil type is conducive to that higher stream sizes, so in this case you have the ridges which are separating which are going parallel to each other not exactly parallel but they are going along the step and on this side you are having 2 ridges which are perpendicular one ridge here the other ridge at this location, so this channel can be used to collect the surplus water which may be used in the next step, so this is again a method of flooding where you are not flooding in the same manner as you are doing in the ditch

method where the water was flowing along the ditch, in this case the water is flowing at some field channel which is at the upstream end.

So you release the water from there it moves into this and then the surplus amount is collected it might go to the next field, so it is normally used where you have the field to field flooding. In areas where for example the Delta areas where you do not have any problem of the amount of water available in our Kaveri Delta region we are using this method where you are letting the water flow from one area into another area and with the consequence that most of the time the water might be standing there.

So that is the reason that you using the paddy, the paddy crop is quite popular in those areas because paddy needs the quite a lot of water and in this method you can provide that water because the water is coming from one field going to the next we will going to the next field and that continues and this method can also be used for other crops which are not very sensitive crops for example the grasses can be this can be used the other crops can be fodder crops again you can use this method you might not have that continuous supply you might have intermittent supply because the fodder crop again they cannot sustain that longer inundation.

So the adaptability of this method again is quite similar that you are you can use it for those areas where you do not have any availability of excess labour, the labour cost are very less in this case otherwise the land forming cost can also be reduced by not grading the areas even if there is some problem in terms of the levels you might since the depth of water is quite excessive, so the distribution might not uniform but at the same time distribution loss can be compensated by the amount of expense which is saved. So these methods are not a general-purpose method they are specific purpose method where you can you can justify these methods in some conditions under some situations where either the suitability or the economic conditions of the farmer or the type of crop which you are growing they are the major deciding factors, so with that we will conclude the methods which are surface irrigation methods as we have defined in the beginning.

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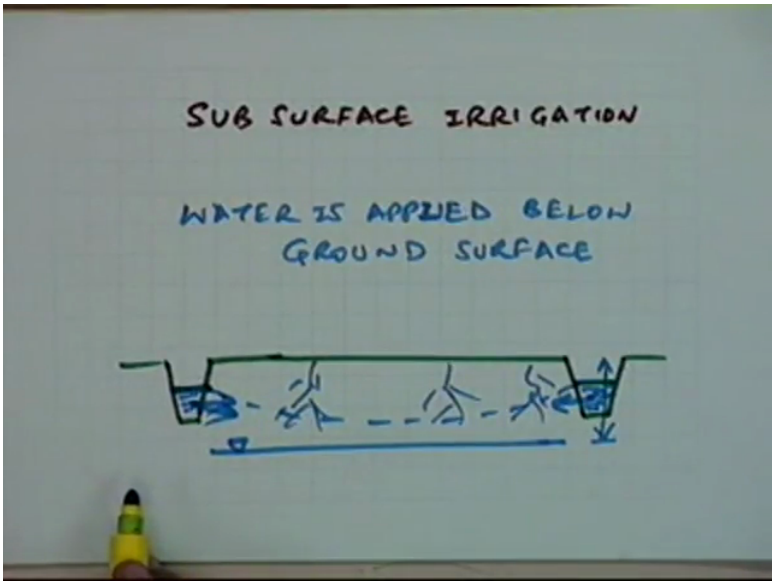

We will go down to the next class of irrigation methods which we were which we had started with along the surface irrigation method we had set the sub surface irrigation method. Now in this category of irrigation method we are supplying water, water is applied below the ground surface, so this is the basic difference between the surface irrigation method and the subsurface irrigation method. In the case of surface irrigation method we have seen that we are making use of the gravity flow but the water is travelling over the surface of the soil or the ground whereas in the case of subsurface irrigation the water is not travelling over the surface of the ground but is travelling within the ground surface below the ground surface.

Now what kind of method this can be, if you just try to visualise you will find that the typical… Suppose this is your ground surface, now if you want to make the water because the root zone depth we know, this is the root zone that and which we are interested in, we want to supply moisture to the root zone depth this area because the plant would system is in this area and because of that fact this needs moisture, now in case of subsurface irrigation there is a way out that the possible solutions are that you either provide the some sort of ditch, you have a ditch where you control the water, you have a ditch where you have…this is the water level.

Now this what level is under your control what will happen if you maintain this water level here and if the groundwater table is somewhere down below depending on what type of soil you are using? What type of solace prevailing? There will be some flow from this area in to this area, some water will flow into the zones again it will be a function of how much water

will flow, it will be a function of what is the wetness of soil and what is the relative location of the groundwater table?

If the groundwater table very low most of the water might go down some water might go in the lateral direction as we have seen in the case of furrow irrigation but this situation when we use a subsurface irrigation we are basically using this irrigation when the groundwater table is already very is quite high, you do not use this irrigation when the groundwater tables are very low because in that case most of the water which will be making available in the ditches because this water has to be made available artificially you have to bring this water from some supply source this source can be either the canal water or it can be the groundwater which you have pumped and put into the channel system, it can be any source.

So this is the level which you have created here in the ditch and the level which is the groundwater table, if the groundwater table is somewhere here you will find that after sometime there will be some level stabilisation if you keep on supplying this water there will be some flow from the ditch into this area and the water table might come up locally, now this rise in water table is within your control if you find…

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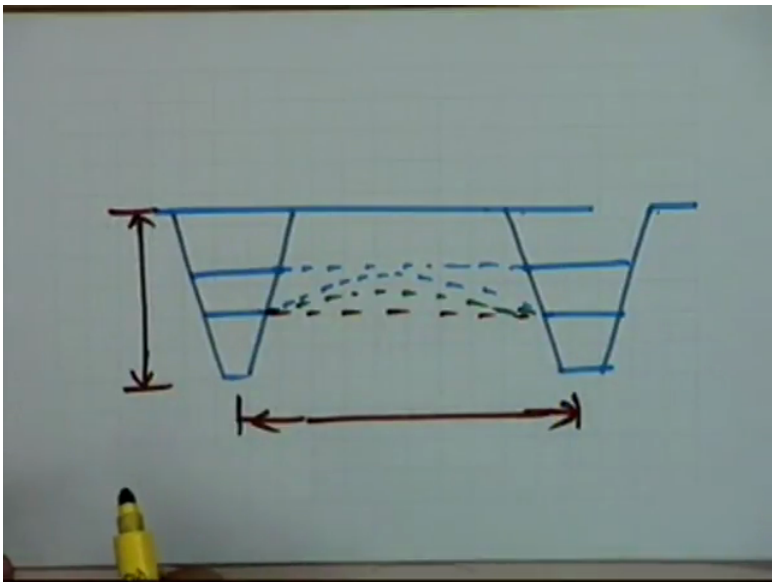

Let me put this here again that if I have ditch which is a longer ditch, if I have this is a ditch, now in this particular case by controlling the level of water if my previous water table was… this is the water table its I have established after a long after controlling this level for a long period you will find that this will stabilise, the water will keep on moving on this side it and

depending on the soil type, if the soil type is quite porous this might be achieved relatively in a quicker manner.

Now if this is a level here which I have attained it has become quite excessive I can reduce this level while removing water from the ditch this will come down, initially it will be like this after sometime it might become this and after some more time it will this will be achieved, this fluctuation is what is in your control and that is what you do in case of subsurface irrigation, the design parameters which you have to look at when you design the subsurface irrigation are what should be the spacing between the ditches that will decide up to what level the water table when you when you control these levels of water in the ditches how much time it will take for the water to drop down to the level, desired level how much time, how quickly it will do that because that is a function of the soil type.

What is the hydraulic conductivity of the soil? Is that will decide the moment of the water into the soil, so depending on the soil type you can design what should be the spacing between the ditches, you can also design the other parameter will be what should be the depth of the ditch as that will give you the flexibility on up to what level you can control that the water depth and then you can also decide on what will be the size of the ditch, so these are some of the parameters which you will design, now this is one option available that you have the ditches, if you want to choose another option which is quite an usual option, you might replace these ditches with the circular pipes.

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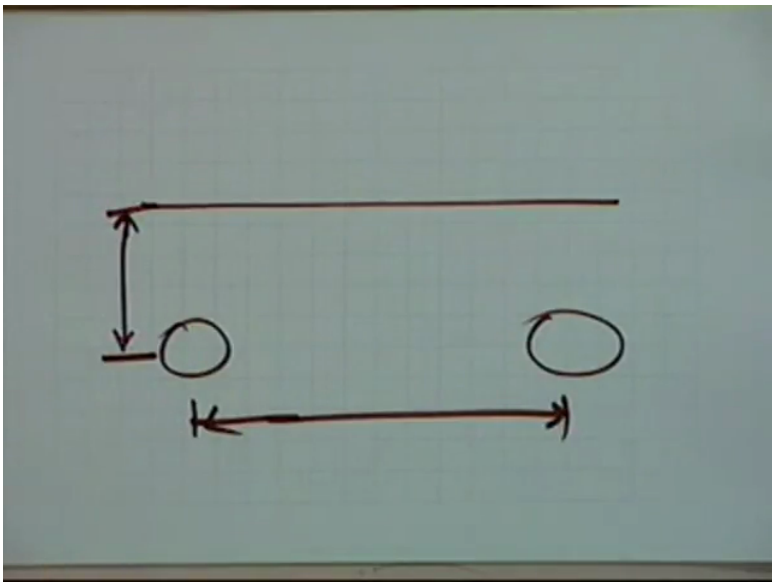

You have this instead of having ditches you can have underground pipes which are having perforations the water passes through these pipes and it gets it does the same job as is being done by the ditches. In that case you can save area which is utilised by the ditches, so that much area can be saved. In this situation also again you will have to decide what will be the depth up to which you have to lay down the pipe? What will be the spacing between the pipes and what size of the pipe has to be used, so these are some of the parameters which will be needed to design the system, how the system should be laid out and that will be also a function of what type of crops you are utilising, these methods whether it is whether you are using the ditch or whether you are using the perforated pipe and a ground pipe for the subsurface irrigation.

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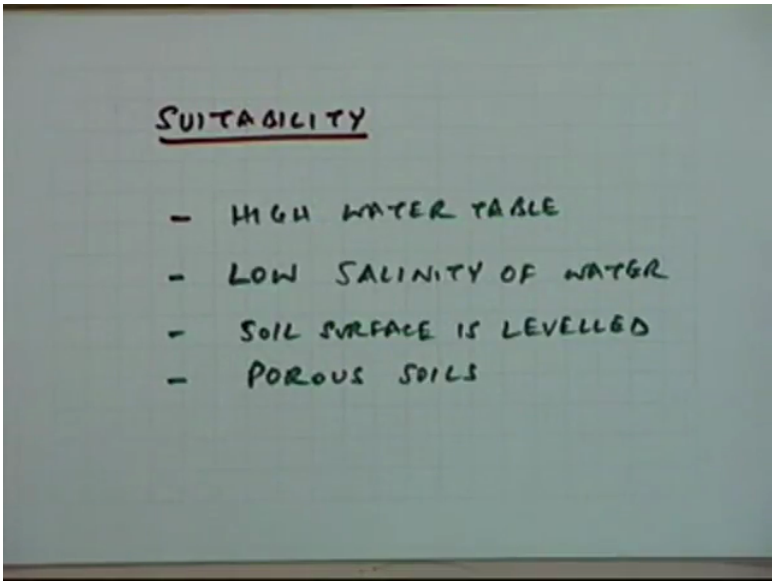

In general the you will find that the suitability of this method is quite is not used at many places there are lots of restrictions in the sense that you have 2 use this method where you have the water table is quite high. You cannot use this method whether water tables are very low because as we have discussed that it can is loose lot of water as deep percolation. You should use this method only when the salinity is quite low because if the salinity is high then by what it does is that since the water table and that area will be already very high.

Now as you use this method the chances of evaporation because the water will be coming to the top of the ground level because of the capillaries as that is one of the way by which your root system is getting water, so if the salinity is very high the chances of salts coming to the top of soil is very high because of the evaporation from the soil. So you avoid this method when you have low salinity the high salinity water then you should avoid this method. Then

is suitable when the soil surfaces is levelled because this method the type of control which you are talking about if the area is having lot of slope then the ditches want to function very well especially in the case of ditches you are trying to have the ditches where the water is only being maintained with respect to the inputs which you are giving into the ditch and the levels are maintained from one area to another area.

You do not make the water run with velocity is only maintaining the levels of the water, so most of the time you will try to use this this method when the level the areas are very well levelled they are flat areas and you are not bothered about the flow of water because you are making the water, they are all interconnected ditches, so once you put the water in one location the water will automatically move into the other locations also and this method is quite successful when you have that type of topography. To give you an example this method is very successful in Holland, in Holland as you might be knowing that the Holland, the general level is below the sea level, so there they are using lot of (())(28:59) to keep the seawater away from their land and therefore they for the floriculture the tulip cultivation is being done using this method of the ditch subsurface irrigation method.

There you will find that the water table is already excessively high, so they are controlling of water in the ditch and maintaining that level either by pumping the water out of the ditch most of the time so that they can keep the level at a desirable level. Then another suitable condition should be that the solids should be relatively porous, so that you have to use very small spacing between the ditches. Your spacing to have the spacing large enough you should have the soils which are porous soils so that the water can really travel fast within the ground and it can stabilise maintain that level which you are trying to control, so from those angles I think you will you will get a feeling that this method is again a method which is which has lot of restrictions and it cannot be a method of very usual nature. It is a specific purpose method with the suitability only in those circumstances where you have these conditions met.

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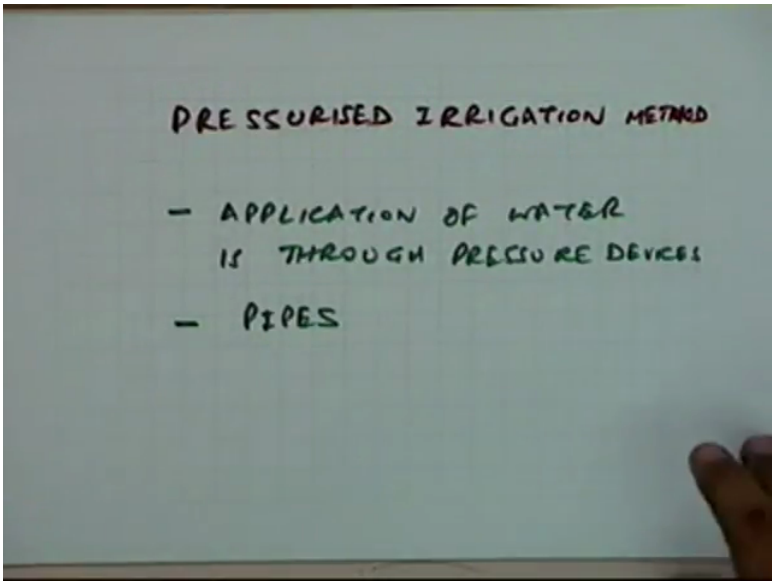

Let us go to the last class of methods which we have defined in the beginning that was pressurised irrigation, pressurised irrigation method. This method is in general is the one where your application of water is through pressure devices and again as far as the distinction between the surface and subsurface is concerned this method is in general surface irrigation method you are applying the water onto the surface of the land onto the ground surface whereas in some cases you might find that specially in the case of drip irrigation system, we will come to that you might be supplying water not exactly on the surface but maybe slightly below the surface but that is again the level is very small and that is (())(32:57) with a specific purpose but even in that case it will be called a surface irrigation method.

So between the first 2 categories this will belong to the first category with the only distinction that your application of water is through the pressure devices that means ultimately when it comes to the application stage is through the pressure device because of that requirement even the previous system, the whole system you have to have under pressure otherwise you do not have any other means provide that ultimate pressure at the application level, so it becomes essential that you have the pipes the water will be flowing through the pipes the source, from the supply source you will have to carry the water all the way under pressure.

So that ultimately when you come to the application level you might use any type of device but the water should be still under pressure, so that you can supply that water under pressure, so that is the basic difference between this method and the previous method we have discussed. There are many different variations of its pressurised irrigation method. They can

be different categories they are either dependent on what type of devices you are using or what is the order of magnitude as a pressure is how the devices will also be varying.

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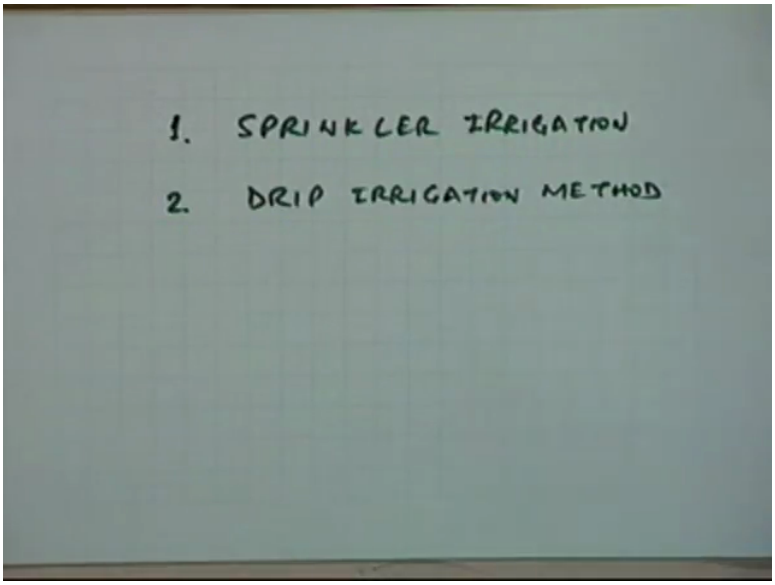

There are many classes of such system but the 2 which have become highly popular will discuss those and these are first one is sprinkler irrigation system and the other one is drip irrigation. These 2 methods are the ones which are basically the basic reason why this that these methods have come into picture, why they have been they have come into being is the scarcity of water. That was the basic reason that people thought of different ways of saving water and by doing so they felt that if they use the sprinkler irrigation…

Sprinkler irrigation in comparison to the drip method, the saving is not much that has been found later on but the intention was to save water that was the first intention but the drip irrigation is further refinement of not the refinement but the further research into how you can save water in those circumstances where the water availability is a limited quantity and how you can make use of that limited quantity of water to get the maximum yield per unit water. With that with the objective of this method came into being and Israel is the country where the sprinkler irrigation as well as drip irrigation method has been…they have pioneered these pressurised system and even now I think they are one of the leaders in these 2 irrigation methods.

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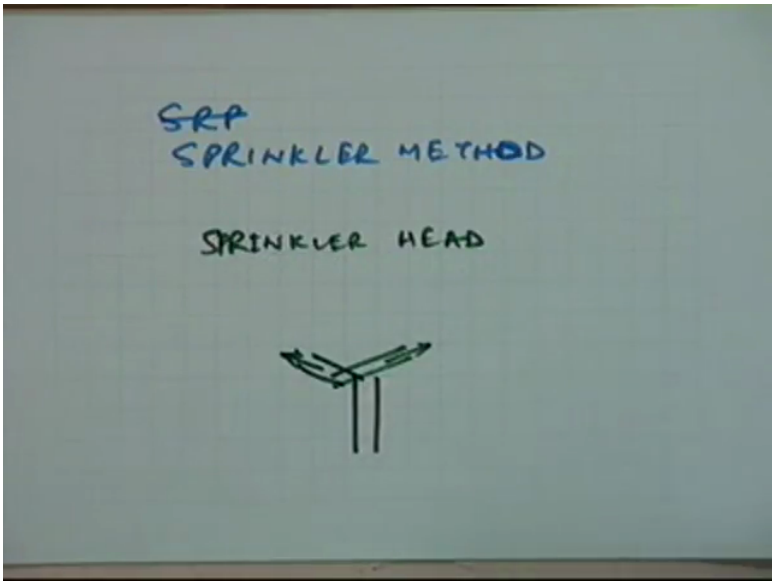

Let's look at these methods one by one first let us have a look at sprinkler sorry sprinkler method, now in this method the water is supplied through the pipe network has will we have said that ultimately the device for application to be used in this particular case is the sprinkler head. Now the sprinkler head is a device which sprinkles the water, the name suggest that it sprinkles the water over the surface of the ground. You might have seen the sprinkler heads walking in some of the gardens these days, some of the lawns and there are sprinklers which are very small sprinklers which can be used in the lawns, which can be used with the tap water which you are getting in your houses, so those that device is called the sprinkler head.

This device has a sprinkler head which is nothing but there are different types of sprinkler heads it is a device which lets the water go out since the water is under pressure it goes out in the form of a jet and that jet is broken with some mechanism, so that it gets distributed in different droplets, so that is the basic philosophy of the sprinkler head, it disintegrates a steam jet into smaller water particles and those water particles are sprinkled over the ground. You can either have a single nozzle head or you might have a double nozzle head where you have 2 jets coming simultaneously and they are distributing the water over the whole area, so this this sprinkler head, it rotates around its axis in a circular with a circular motion and that motion can also be changed, it can be fixed.

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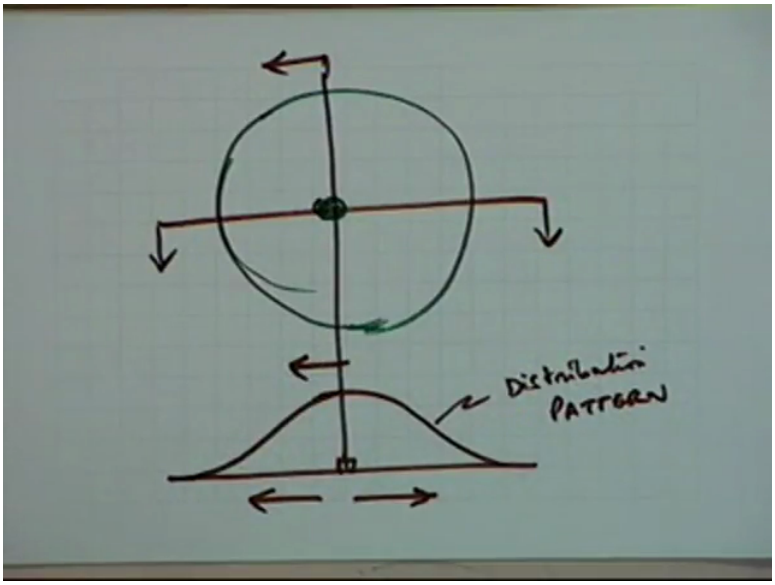

So if you look at the plan if you have a sprinkler head here the spread of the sprinkler head will be a circular area and if I look at the distribution how much water has been distributed? Now this is the axis where I have located the sprinkler head and this is the distance in both the both sides. The spread might be something like this, this is known as the distribution pattern, this is the distribution pattern of a single sprinkler head, okay.

So when the sprinkler head will be sprinkling water in this total area, this is the I have taken a section view at this level even if you take the section at this level you might have a similar section and this is what is the basic philosophy of what the sprinkler head does? Now you might say that if this is the distribution of a single sprinkler head then this is quite an uneven distribution, we started with thinking of those methods by which we can have a uniform distribution for the total field.

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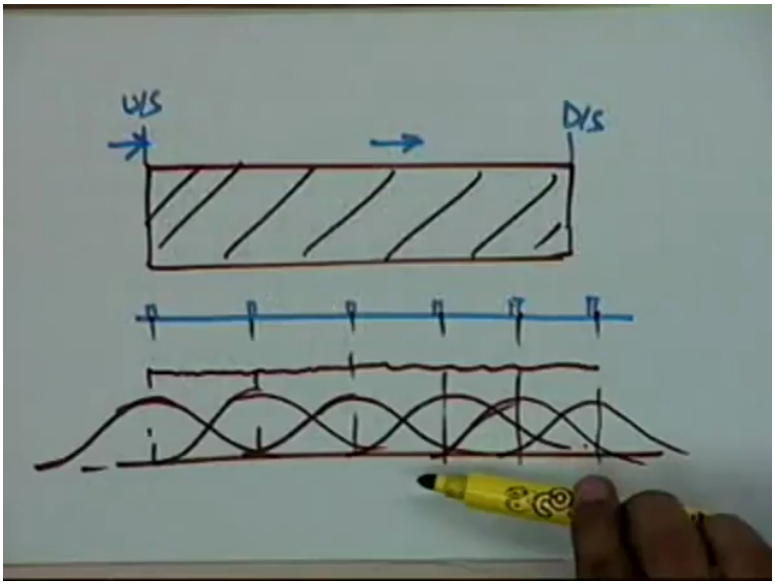

For example this was the field we had this was our root zone depth, we wanted a uniform distribution over this whole area and in this surface irrigation method we have seen that we cannot achieve this because of the fact that the water flows from the upstream end to the downstream end and that is why there is uneven distribution because this gets more water, the upstream end segment of the field gets more water than the downstream end, so this can be avoided with this sprinkler irrigation method, now in this case what I want to do is I want to spread my if this is my total longitudinal direction, I might try to have the sprinkler heads spaced in such a manner that I get when I when I try to overlap each one has its own distribution pattern, the other one also has its own distribution pattern, the 3rd one and so on. When I look at the distribution pattern of the total combination is the end result is a combination of all these distribution pattern and I might get something of this nature, okay.

So it is the overlap which is important that how each individual sprinkler head which is spaced at some spacing, now that spacing is important, that spacing is what we are interested in knowing, that is part of the design when you design the sprinkler system later on we will see and that is something which we want to look into what should be the spacing? Because that will be a function of what will be the distribution pattern, distribution pattern can change with respect to the pressure with respect to the nozzle size and these are the 2 major factors which will decide what will be the…what will be the distribution pattern of sprinkler head? But this is the basic philosophy.

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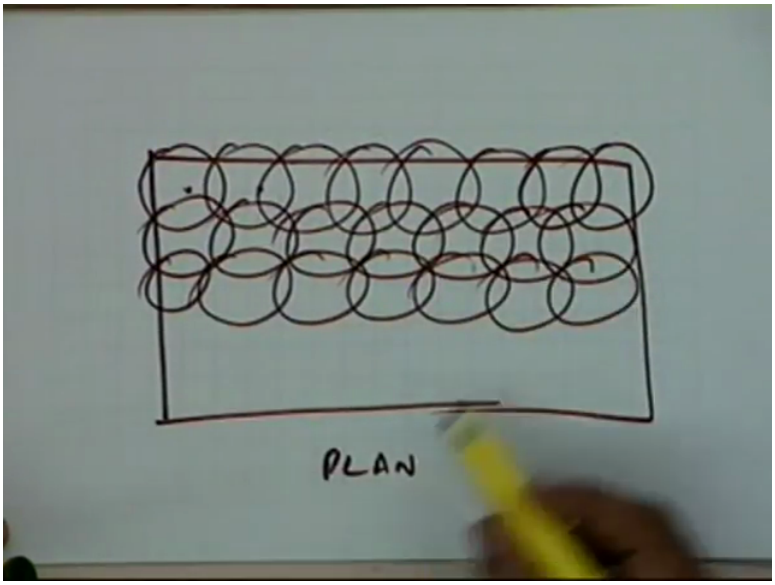

Similarly this overlaps this is one overlap in one direction, the let me let me put the whole thing in plan, if I show the field in plan, now I might locate the sprinkler head in such a way that this overlap which am trying to look at which will give me a good distribution, uniform distribution will have to be considered in both the directions, so if I consider these 2 rows of sprinkler nozzles and I look at the overlap of both these rows then in both the direction I might get a good distribution of water which is the desired distribution.

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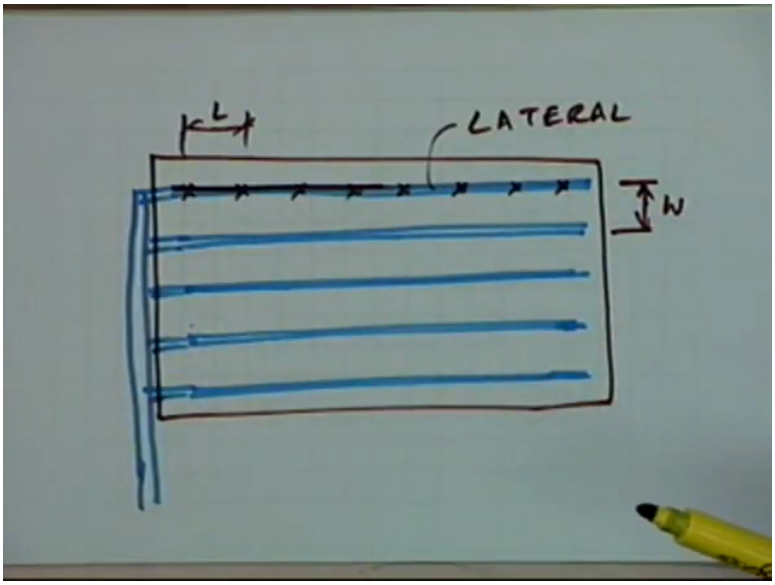

So this is what is done that you are trying to trying to find out what is the…Now I am drawing the pipeline for this field in plan again to achieve these individual sprinkler head distribution I might have let me use another shade, I might have a 1 pipeline running here

another pipeline running here and this might be the total layout of my pipeline which is getting which is connected to another bigger pipeline. Now on each of these locations I have these are the nozzle head which are located at some spacing, so my design parameters will be…what will be the spacing between the nozzle head let me say L, what is the spacing between these 2 pipes and each one this is normally the nomenclatures is this is called lateral is the lateral pipe on which you are installing these sprinkler heads.

So what is the spacing between the sprinkler heads? What is the spacing between the laterals that has to be decided on the basis of what is the distribution pattern of each individual sprinkler head and water spacing is needed to have a uniform distribution that is what you do in case of sprinkler system and then the other design parameters can be the sizes of these types and because that will depend on how much are the losses in terms of the pressure variations because since we have just mentioned that the distribution pattern will be a function of the pressure available, so the pressure drops very much your distribution pattern will be affected, so all those things will come to later on but at this stage we are just trying to see what is being done in this particular method. Now having known this let us look at the suitability of this method, what are the various conditions under which this can be suitable or…

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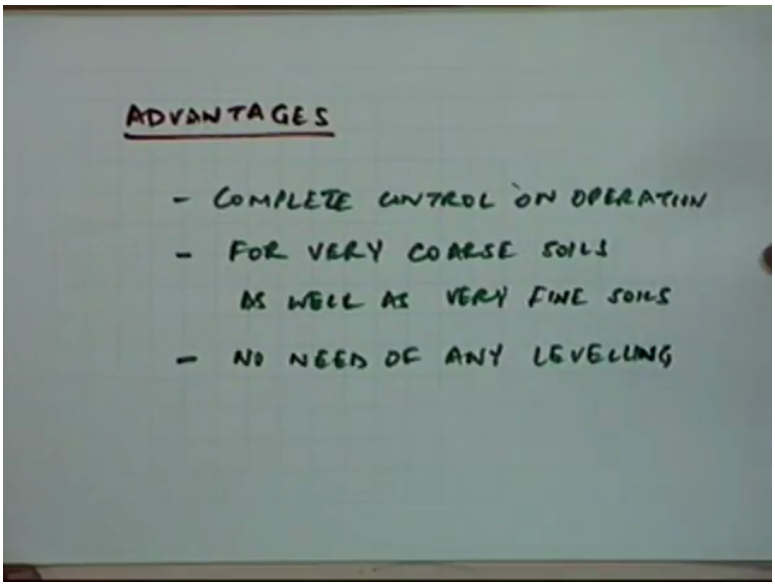

First of all let us look at some of the advantages which will also cover the condition under which this method can be suitable, what can be the possible advantages? The first advantage is that you have complete control on the supply of water, complete control on operation in terms of if you want to run the system for a very short period you can afford to do in this

particular method which was not possible the case of surface irrigation method. In the case of surface irrigation method if you it might not be feasible but if you are willing to apply a depth of 1 centimetre of water it may not be possible.

In some soils it may not be at all possible because while doing so you might find that you have created lot of disparity in the amount of water which has been ultimately made available at the upstream end and the downstream end whereas in this case you can run the system or a very short period and you can afford to apply any depth any depth which you find a feasible all you want to apply the depth onto a particular area you can afford to do that. Then the other advantage is that you can use this for very coarse soils where no other method is suitable because if the soil is very coarse, now in this case you are not supplying the water from one end to another end since it is coming as in the form of rain as the rain comes you can you can apply unto any type of soil whether it is a highly porous soil or even if it is the other extreme where you have very low infiltration rates, in that case what is needed?

If you have very low infiltration rates if you use a conventional surface irrigation method you mind find that most of the water is getting lost in the form of run-off whereas in this case you can afford to reduce the supply the design can be made in such a way that the rate of import or the rate of application can be reduced and over and above that you can have more intermittent irrigations, you can have more frequent irrigations which is not possible with other methods. So in this case you can have this method suitable for very coarse soils as well as very fine soils if it comes to that situation but at the same time if the amount of water which is or the level of application is very high then I think it is not worth for going in for this method because if the level of water application is very excessive then it is better to flood the area than going and for such a method.

Then in this case you do not no need of any levelling, so the land levelling you can use this method for undulating areas where no other surface irrigation method is this possible or is useful you can use this method because in this case you do not have any problem of the terrain, is the application the rate of application is in your hand, you can wait for the soil to be dry so that next time when you apply the irrigation water there is no surface run-off because in the beginning the inflation rate will be high, so unless you have breached steady-state infiltration rate you will find that most of the time in most of the soils the infiltration rate will be comparatively higher, so in this method you can afford to make use of those advantages and you do not the mere fact that the levelling is not required that is a big boon. With that I

think I will stop here today and we will…in the next class we will continue with this and go onto the next method of drip irrigation. Thank you.