Water management
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Lecture No 17
Irrigation Methods (Contd.)

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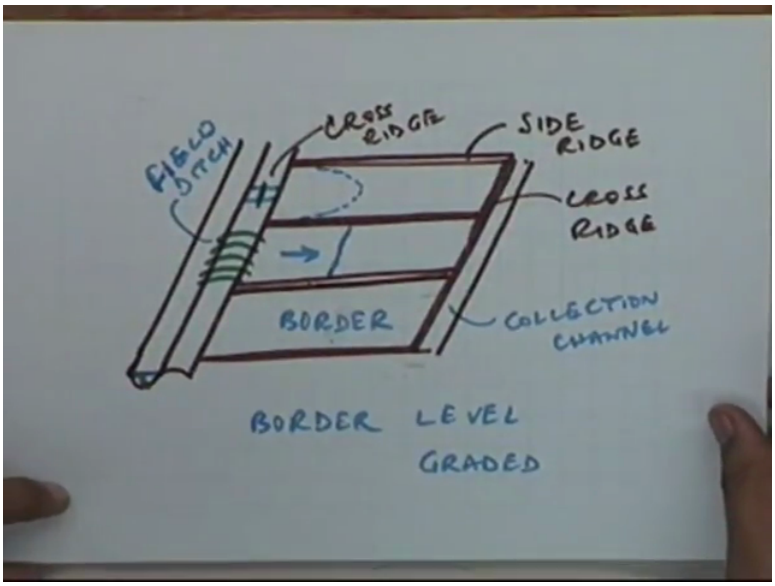

Okay, in the last lecture we were discussing the borders irrigation method and we had seen that in this method this is the layout which is series of parallel strips which can be led in such a way that you can irrigate them from the same field channel or field ditch and we had also looked at the various other requirements but they are the requirements of having the inflow made available at the upstream end in such a way that you have a parallel waterfront moving in the downward direction this will enhance the distribution efficiency.

Then we also discussed that there can be a border irrigation or the border strips which are either levelled or graded because in this method it depends on what is the what is the existing grade which is available in the area in which you are going to lay these fields. If the existing grade such that you already have levelled land the grade is very minimal there is no need to give it a grade which is which is appreciable because that will involve a lot of investment but at the same time it is not dependent only on the method, it also depends on which soil you have in that area. So these are some of the parameters which will come to when we will go in for the actual designs that how these various parameters affects the selection of the method as well as the laying out of fields within the same method, how a specific size can be influenced by those parameters?

So at this stage I would like to mention that if you have an area which is relatively levelled area you can still use the border irrigation method, the border strip can be made use of by controlling the stream sizes. What is the stream size which is available at the this particular level from the ditch, what stream size can be made available in the border? That will decide along the slope if there is some slope, how the water will move?

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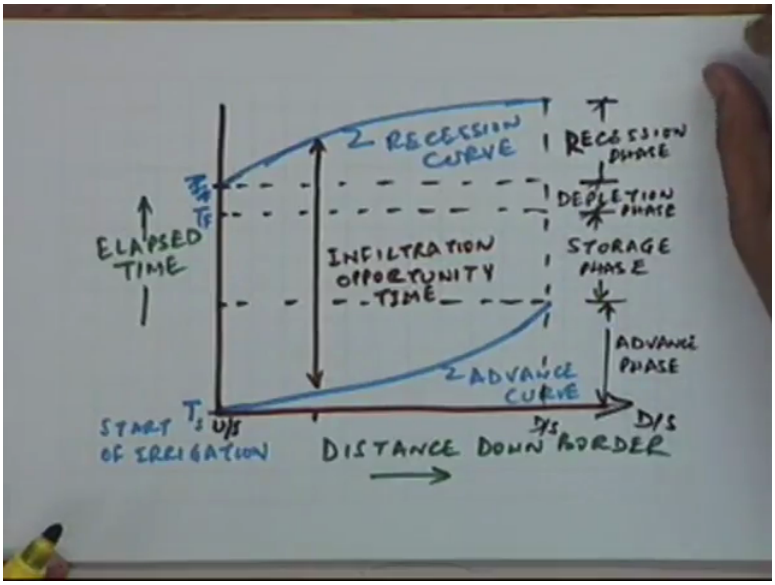

In general let's see that in general if you look at what are the various phases of the water moments, you will see that there are 2 stages if I plot, if I make a plot between distance along the border on this axis and on this axis I plot the time or even I can call it elapsed time on this axis you will find that if this is the time when I start the irrigation this is the time corresponding to the start of irrigation. That is the time when I started supplying the water in the upstream end of the field.

This curve is a typical curve which is called the advanced curve, this curve shows that how this water is moved in time from the upstream end, this is the upstream end let me put that this is the upstream end of the border and since this is the plot of the border length as we go down from upstream end to the downstream end, so somewhere here you have the downstream end, where you have the downstream end it will depend where what is the length of the field, so the length of the field is only extending up to this level then for this field this is the downstream end, okay.

Now this length is one of the parameter which has to be designed you have to evaluate what is the length which should be selected, so this is the design parameter under the various

combination of other influencing parameters which includes the slope, the stream size, the type of soil all those put together under all those combined circumstances what is the best length which can be selected that becomes one of the design parameters. We will come to those things later but at this stage I am just trying to wherever possible I am trying to bring in those aspect so that you can try to understand what is the need to go into all these things when we discussed various methods of irrigation.

So if you divide the total time for which you are applying irrigation water and even beyond that, that can be distributed or that can be divided into different phases in to different stages and those stages we are trying to look at, what are the various stages during the process of irrigation which are prevalent not only in the case of border irrigation but in other surface irrigation method as well, okay. So this is the advanced curve a typical advanced curve, the shape can vary from field to field depending on the other characteristics that is what you had wanted to know the other day.

This shape is only a typical shape, it may not be same for the next field if the some of the parameters changed, suppose if the slope changes, the shape of this advanced problem also change. If the stream size changes or the rate at which you are applying the water at the upstream end, if that changes still this advanced curve will also change, if the roughness coefficient of the field changes which can change with respect to the soil, which can change with respect to the crops which are growing or the stage of the crop again this advanced form will change, so for the same field in the same field we might find that for different timings during the growth stage of the crop this advanced curve might keep on changing.

So it is not a fixed thing it can vary even for the same field if you look at from the time when you have just sown on the seed and you look at the time when the crop is just about to mature or even during this period the advance curve might keep on changing because of the fact that the resistance to water will change and the time taken for the water to move from upstream end to the downstream end will also change. So this is one stage then in the stage let me say that this stages or this particular phase I will put it as a phase which is advanced phase. What happens once the water has started being made available at the upstream end there will be some build-up of water, so there will be stage depending upon if you keep on supplying the water there will be some build-up and there will be a phase during which that build-up is taking place, so this phase we can call space as the storage phase, okay.

Suppose if you decide to stop the irrigation somewhere here, this is the time this is a time when you finish the irrigation sorry this is the time when you finish the irrigation not this one, so from the time when you finish the irrigation there will be some time some time elapsed within which the storage which has been build-up will start depleting and it will be fully depleted, so that phase you can call that phase as the depletion phase and that build-up how much water has been build-up will be a function of again things like what is the slope, what is the prevailing slope in the field.

If the slope is very small the build-up will be higher. In that case it will take more time for this depletion phase to be over and once the depletion phase is over then you have the next phase which is recession phase and if we plot that as we have plotted the advanced curve because the recession will again is the is the curve which you have drawn with respect to when the water has got depleted from each point in the a long the distance of the field, so if you have observed various sections in the field as you go along in the longitudinal direction you will find that will take some time if there is some slope then it will take some time for the water to get depleted and it will get depleted the earliest at the upstream end then it will get depleted in the downstream end at the last thing in the total process, so this is the recession, recession phase during which the water recedes past each of the individual stations.

Now these of the total number of typical phases which you will observe whenever you go in for the irrigation of any field through the surface irrigation method irrespective of whether you are using border irrigation or the other irrigation method which we are going to discuss, this will be observed the order of magnitude or how these what is the order of magnitude of the depletion phase in border irrigation, with the border what will be the order of magnitude, how much time will take for the depletion phase to be over is the function of other factors like what is the slope? As I mentioned earlier, so these order of magnitude can change but in general all the all these this is recession, this is known as recession curve and the advanced curve.

Now this layout or this picture which we have drawn, if we plot this advanced and the recession curve for any field you can get from this a very useful information, the information about the infiltration opportunity time at any stage, if I want to know at this length at this particular point along the field what is the opportunity time, what is the infiltration opportunity time? The difference between the advanced curve and the recession curve is the total time available for which the infiltration activity can take place, so this is a very

important aspect which can be utilised to find out what is the amount of infiltration which can occur at different locations of the field.

This is known as infiltration opportunity time which means that what you are interested in, you are interested in ensuring that the infiltration opportunity time should be same throughout the length of the field only then you can ensure that there is an equal distribution, there is a uniform distribution of water all along the field of the field of your interest, so if you can ensure that if you can find the combination of various combination of parameters by which you can ensure that the filtration opportunity time does not vary much when you go from one end of the field to the other end, then you have achieved your objective because that will ensure that you have a very good uniform distribution of water and you can see that in that case you can even extend the length of the field or you can control the length of the field.

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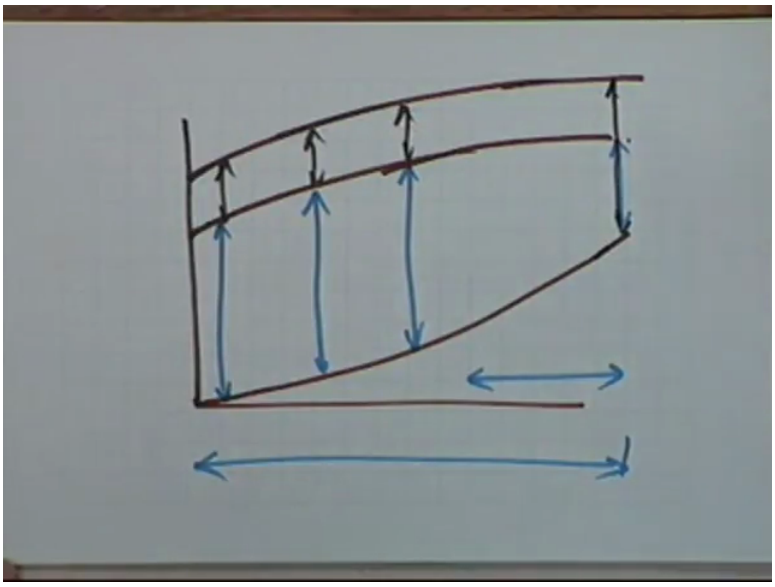

What happens in general let me say that if I have this, in general if I still extended beyond a level I have, I have this situation, now you will find that a general trend of these 2 curves will be like if this is the trend then if I try to evaluate this with respect to the infiltration opportunity time from here and these 3 cases the difference might not be much, the opportunity for infiltration of water was almost equal and these 3 locations but when I go here at this level the opportunity for water to infiltrate into the soil is very small because of the fact that the water has reached here very late and because of the fact at the combination of all those stages, the amount of time for which the depletion phase has taken in all those things put together, all the phases put together the end result is that here the opportunity time is

drastically reduced in comparison to the opportunity time being available at the other locations.

So if I go in for such a length if I go in for this much length of the field I might I might even looking at this I can say for definite that the length beyond this level somewhere beyond this level will be having the moisture made available which is much lower than the required moisture. In case I want to take care of this requirement at the end of this field then I will have to waste a lot of water in this region, so in either way if I if I ensure the if I match the availability with the requirement in this area and this length then I do not satisfy the requirement of the remaining length, if I try to ensure that the requirement of this latter part of the length is taken care of I will have to end up in wasting a lot of water because in that case what I can do I will have to supply water for some more time and ensure that I take the this recession curve or the recession curve is started later on, so you have supplied the water for a longer period, okay.

In that case now I have availability at this location also which is equivalent to this particular level which is almost similar to the previous one but in the process I have at these locations I have added additional opportunity time which will ensure that there is some wastage, is that clear? That is where by analysing this opportunity and recession the infiltration opportunity curve through the length of the field by plotting the advance and the recession curve you can gain lot of information and that can be used you will see later on that when we go in for the evaluation of these methods we use this information to evaluate the various methods and to ensure that we are we are taking care of all the requirements in terms of the efficiencies which you want to achieve or we are trying to go to a level where we are within the reasonable level of efficiencies which are achievable efficiencies.

Now giving you an idea about what are the various possible variations in the length and various sizes of these borders when we when we go from one soil to another soil and also with respect to the slopes these are some of the order of magnitude or the ranges which are given here at this stage I think I like to just give you some of these ranges so that you can get a fair idea that what how much is the variation.

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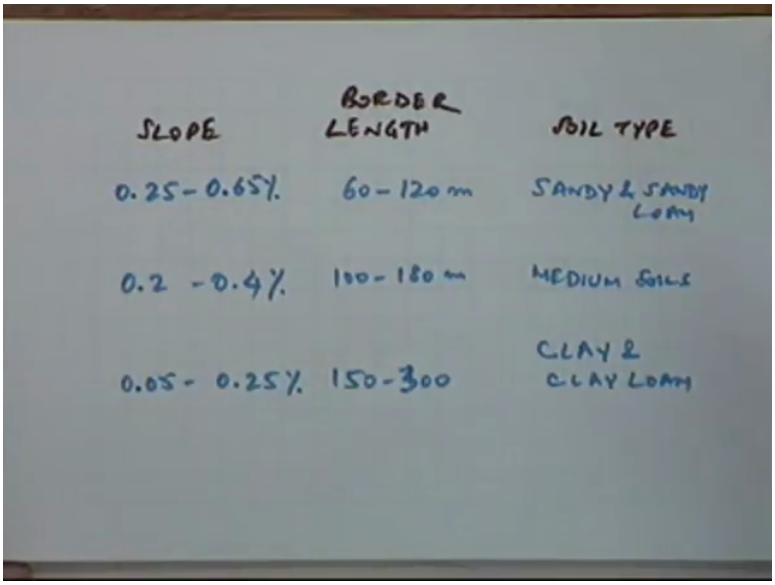

For example if we try to look at these 3 parameters that for different soil type what is the length of the border and also with respect to the slope, when the slope is between 0.25 to 0.65 percent your length of the border may be between 60 to 120 meter for the soils which are in the category of sandy and sandy loam. For medium soils the length can be slightly more than what you can used in the sandy and sandy loam soil and the slopes the prevailing slopes can also be much flatter than what you need for the sandy soils.

Similarly when you go to the other extend of clay and clay loam you can still go in for longer borders and your slopes can be still more flatter than the other 2 cases. Now if you try to visualise what is actually happening, in the case of clay loams or the clay soils the infiltration rates are comparatively lower that is the reason that you can go in for longer lengths because the amount of infiltration when it is low more water can flow into the downstream areas and that is also the reason why you are in a position to even afford to have slopes which are flatter which are relatively lower slopes because again from the same angle that if the infiltration rates are lower otherwise if you do not have.

If you do not have the steeper slopes in this case with the flatter slopes the velocities will be lower and that will ensure is that the rate at which the water is moving in the forward direction will be very slow and as such in these cases in these soils infiltration rates are very high, so it will get more opportunity time or even because of the fact that in this case in all these gravity flow irrigation system we are having a situation where you have the especially varied flow, the discharge is reducing as you go in go along the length of the field and if the rate of infiltration, the higher the rate of infiltration the lower will be the remaining discharge

so that is quite obvious but at the same time there are some maximum limits up to which you can provide these slopes and that is constrained with respect to the erosion.

You cannot provide very steep slopes was in this situation if you can provide still steeper slope might be able to have some higher length of the field but the slope is restricted because of the erosion problems, if you have higher slopes you will have more erosion problem, the soil might get eroded from the upstream ends and it might flow along with the water, so from that angle this becomes a restriction, the slopes have to be provided in accordance with the erosion, there should not be any erosion, even the stream size is you might feel that okay if you want the water to reach quickly in the downstream direction giving very low infiltration time to the soil if it is highly permeable soil if the infiltration rates are very high.

In that case if you choose a very high stream size the rate of flow is very high again you will have the erosion problem stop so both these things, the slopes as well as the stream size they have to be strained with respect to the fact that you have to select these upper limits so that there is no erosion. So these are some of the practical ranges which have been which have been tested over various types of soil and these are the suggested ranges which has been suggested by organisations like (())(29:44) by the they have collected the experience of various researchers and then they have seen that what are the ranges but to go in for the actual because this is a very big range between 150 and 300. Now what is the actual size which should select under the specific conditions of your area that for that you have to go in for precise design and that is what we intend to do to look into how to go in for those designs that is a topic to be discussed later.

Now let us come out with some other aspects about this border irrigation methods and 1 things which comes to your mind immediately is that what is the suitability of this method because ultimately why we have looked at various why we are going to look at various methods is because we want to look at what is the suitability of these methods with respect to different conditions, so if you try to look at the aspect of suitability of the border irrigation method.

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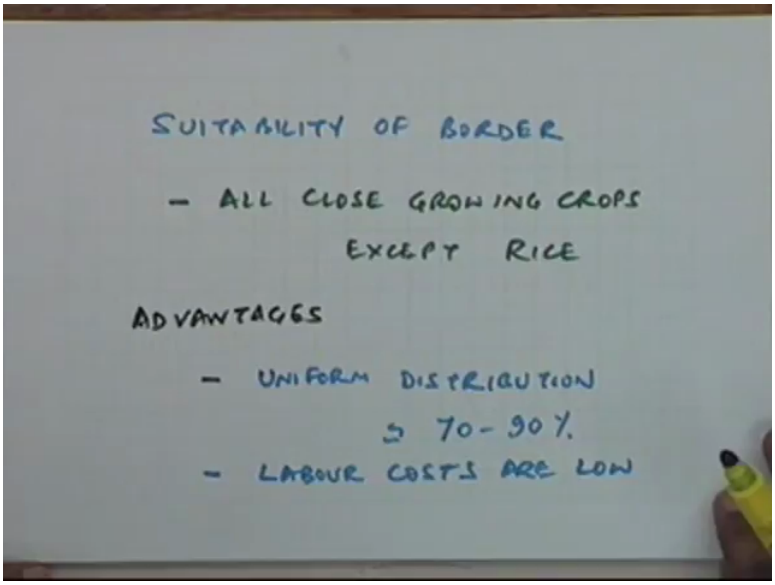

This is basically suitable for all close growing crops except one which is the rice crop. As in the case of rice crop you need the water to stand for some specific period and that is why in the case of border irrigation you do not make the water stand for a long period, it might be standing for some period but not for a longer duration, so that is why normally for rice crops we did not use the border irrigation method but for all the other close growing crops this method is quite suitable. The other advantages which this method has, if you look at some of the advantages the main advantage is that you can go in for a very good level of uniform distribution and distribution efficiency which you can achieve in with this method might range between 70 percent to 90 percent.

Then the labour cost is not appreciable it is not very labour-intensive, requires relatively low-level of labour, yes of course the levelling will be required in this particular case. Normally you do not allow any cross slopes, see the slope can be in both directions, the longitudinal slope is what you want but in some cases you might be might find that area is such that to level the area across the in the transfer direction you might not be able to get remove the total slope, there might be some level of slope which is still remaining, so that should be avoided but with this method is it depends what is the level of that slope, if the slope is such that the depth which you are going to accumulate over the surface, if the slope is less than one fourth of that depth then that is permissible otherwise you might find that there is a uneven distribution across the in the transfer direction and along the field you might get reasonably good distribution but if you look across the field that distribution might be uneven because of the cross slope. The water will have a tendency to get accumulated towards an area that side

which is which is sloping in the in the downward direction that will also create problems in terms of the distribution of water within the border, so that one has to take care otherwise this method is quite useful method and is very popular method where you do not have to you can go in for bigger relatively bigger areas by doing that can reduce the number of channels which you are to provide because the bigger the area the lesser is the density of the new water courses which are needed, so from that angle this method is a very useful and age-old method.

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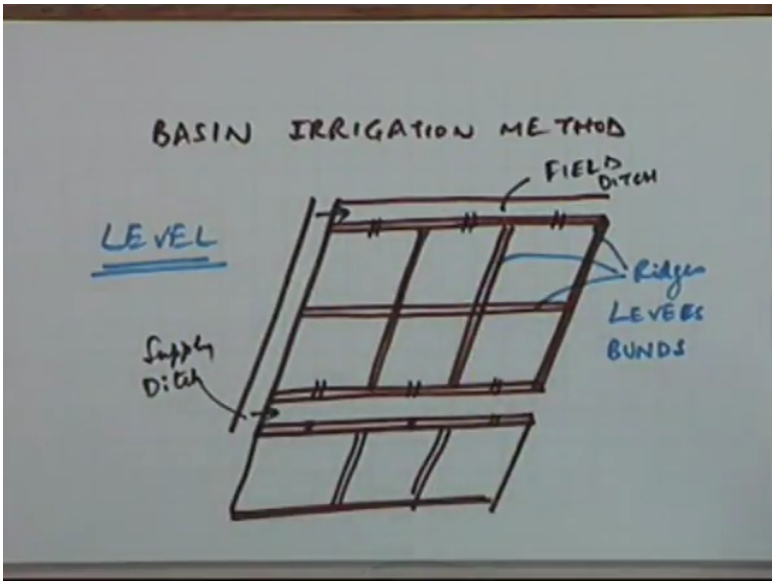

We go from this method to the next method which is the Basin irrigation method. First of all let us look at when we say Basin irrigation method how the layout looks, what is the layout? In this case if this is the supply ditch, you have in this case you have the fields are much smaller in size in comparison to the border method what you get, so if you… This is one typical layout can be different forms of this, so it is not a unique because it depends how you are… In this case I have made a layout in which each one of these basing and this I had mentioned that this is the supply ditch from which you are supplying the water it is coming into the… This is the main ditch and this is the field ditch, the water gets diverted from the supply ditch into the field ditch, so it is from the field ditch that you are providing water into each of these areas.

Now in this case there can be openings into example in this situation you will also find that normally each of these is which is the be providing water to the basins which are on both the sides, so on the other side also you might have another set of basins and that is how each field ditch… it is more convenient to add the water flow into the 2 adjacent basins, so as you see

that each of these basins there are they are surrounded by their edges, these are the edges or you might call give them different names which is Levees or Bunds any name you can give is the same thing, so these are small obstructions which have been created around the Basin.

Now these basins are relatively smaller size in comparison to what we have seen in case of border and they can be either square in shape or rectangular. Now the idea is that why they were needed? In the case of border suppose if you encounter a situation where you have soil which is which is heavy soil, now you can see very well that in the case of border when you encounter heavy soil you might not be able to get to the opportunity time which is parallel to each other for a very long period, so you have to drastically cut down the size or (())(41:14) you can also say that in that situation you want the water to be available at the top of the surface for a long period, it should stand for a longer period, so that the appropriate infiltration can take place.

So it is the either way we can argue from any angle, the ultimate thing is that because of the low infiltration capacities or the low infiltration rates prevailing in the soil you will require the water to stand for a longer period or in other words the infiltration opportunity time has to be sufficient and to do that you want to provide that by having small basins which are levelled these basins are normally they are level basins without any slope, the sizes are small, so with this with this structure with the level sizes of these basins when you apply the water you can make the water stand for a longer period and that water will ultimately infiltrate into the soil.

So that is where so that is how the requirement of a Basin irrigation method was found to be there whenever the soils were of heavy nature and on the other side if you look at the other aspect the other extreme, suppose I get a soil which is very formidable, light soils, sandy soils in that situation also if I use the Basin irrigation method I will I will have to send the water inside the Basin in a very short period, now because of that you will find that you can flood the whole area but in a very relatively very short period and then the water will infiltrate into the soil it might take a very short period to infiltrate again if it is a sandy soil. In comparison to the border I will be much better off using the Basin irrigation method on the light soils than using a Basin irrigation method because of the fact that the infiltration is very rapid but in this case since the size is very small, the slopes are not there you can flood the whole area in a very short period.

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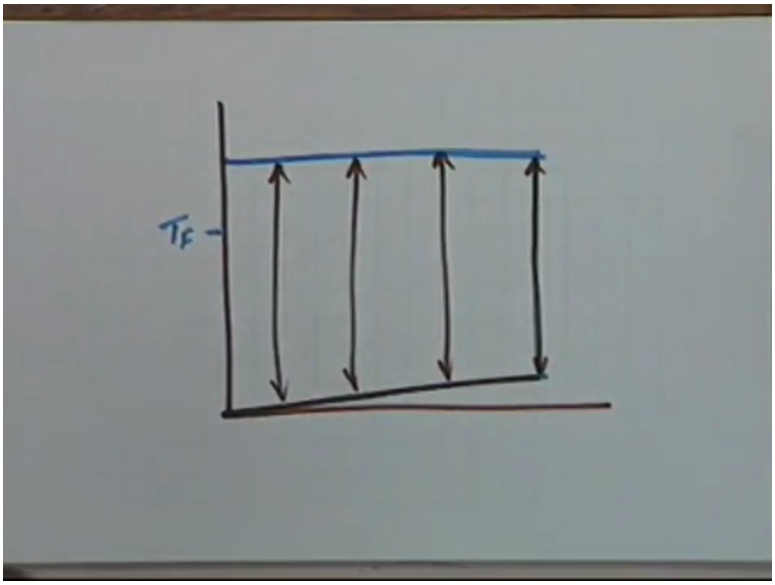

So if you look at from the angle of the infiltration, the advanced and the recession curve typically what we are saying is that if irrespective of which soil I am using I will have an advanced curve which will be very close to the… If I choose a stream size is very big stream size and since is a level Basin the erosion problem will also be reduced I can ensure that within a very short relatively short time I go to the lower end of the field, so the advance curve will be this will be the advance curve and towards the end when I stop, when I stop the irrigation there might be if this is a point where I have stopped the irrigation, the time when you have finished the irrigation the water might stay over the whole plot or over the whole basin for some time and then the recession curve will be something which will be a straight line parallel to the horizontal axis because the water will disappear since there is no slope, the water will disappear from the total area simultaneously, so in this situation by infiltration opportunity time from the upstream end to the along the length of the Basin will be almost similar because of the fact that I have been able to spread the water in a very short period. That is the philosophy of Basin irrigation method and that is the reason because of this fact this is the basic reason that why you can get very good distribution efficiency using this method, the distribution efficiency might reach to the order of around 90 percent.

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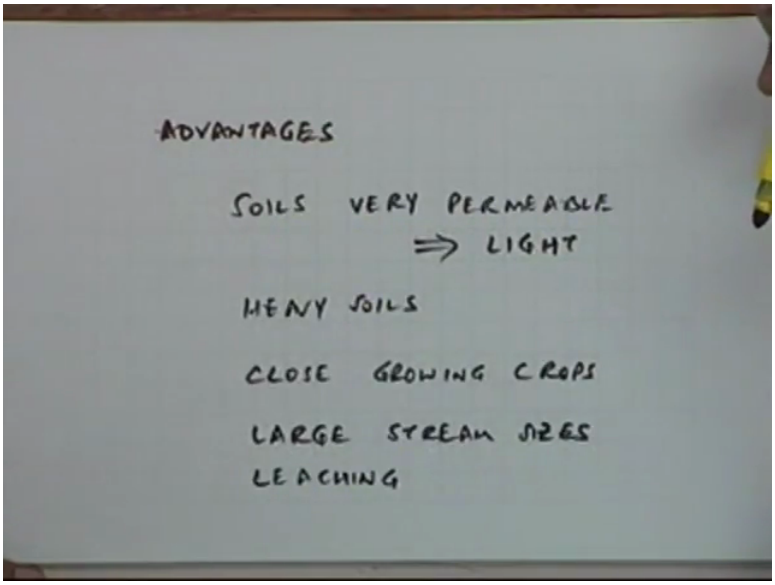

And then the other advantages of this method is you can use it for soils which are very permeable or in other words you have the light soils or the other extreme also not only the light soil, the other extreme is very heavy soils also. So heavy soils can also be very satisfactorily you can use this method basically this is the method which is normally used for the Paddy crop, the rice crop because of the fact that you want the water to stand for a sufficient amount of time so that the water can infiltrate into the soil. You can also use this method for other close growing crops which include the grain crop, the fodder crop.

Most of the grain crops and food crops they are close growing crops so this method is quite suitable. You can also afford to use very large stream sizes if the rate at which the water is available is quite large, you can you can afford to make use of that high level or a bigger stream size available. This method is also quite effectively used for leaching, the leaching of the salts and be very effectively done with by using this method.

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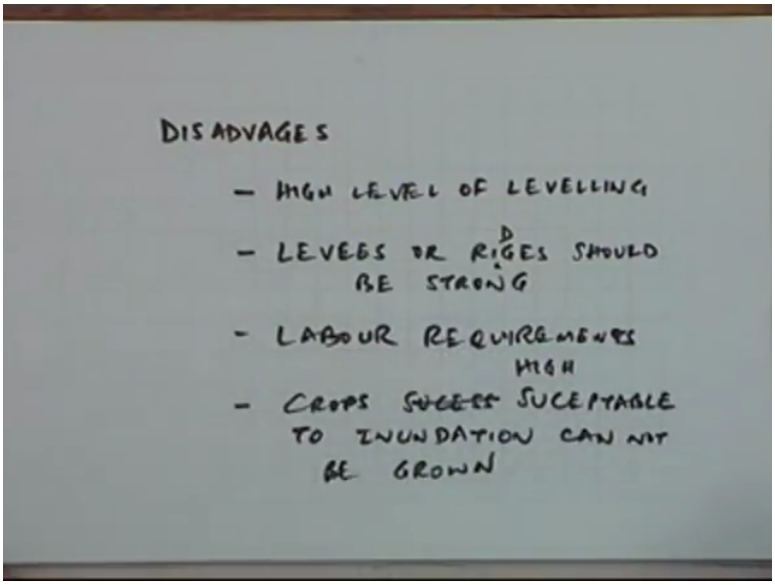

At the same time there are some disadvantages but not very not very many, the basically the requirements is not disadvantages in that sense in first is that you need a very high level of levelling, very precision levelling is required as in the case of border also then the levees or the bunds or the ridges they should be strong enough because most of the time you will have the inundation taking place. Moreover the labour requirement comparatively will be more in comparison to what you have in the case of border, so the labours and from this angle also that if the ridges are not proper they might have to amend it from time to time.

Labour requirements will be comparably be high then another situation where the inundation is a problem all those crops where which are susceptible to the inundation of water or inundation due to water, if the water is standing for a long period those crops cannot be grown with this method, so all the crops which are susceptible, crop susceptible to inundation cannot be grown, now these are some of the disadvantages which you will encounter when you will be using this method. Now as far as the size of the field is concerned the shape of the field is concerned there is no such constraint because in this particular case you are trying to flood the whole area within a relatively smaller time but the same time is always beneficial if you have shaped which is either square or rectangular.

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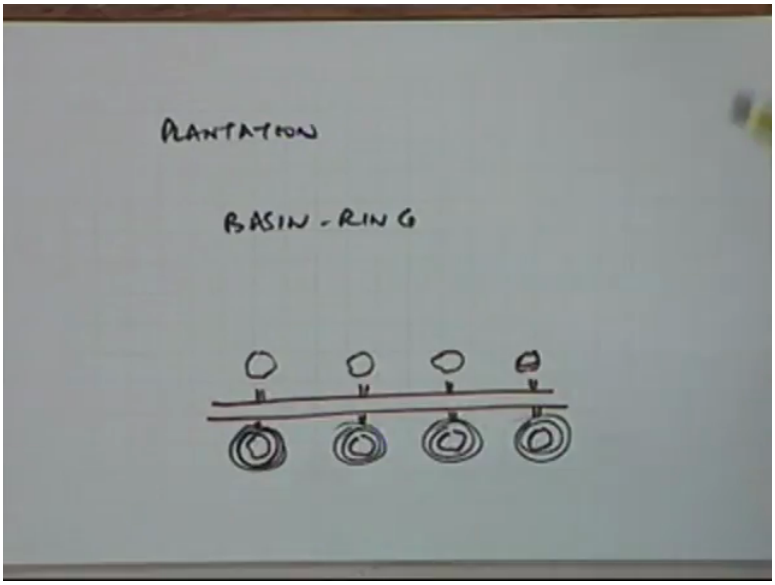

This method is also used in the case of plantation for the orchards for catering to the requirements of individual plant, individual tree, so in that case it is called the ring method of irrigation, the Basin ring method because in that in that case you will try to…if I will draw it in plants if you have these are the trees which you have a row of trees here, now in this case you try to dig a ditch you might be having a supply ditch going through the row of these trees and then each one will be supplying water to the individual plant and around each plant you will you will try to dig a ditch where you can supply the water.

Now that is why it is called ring method. The size of the ditch can keep on increasing depending on how much is the water requirement, how much can be stored in the string around stem of the tree, so as the tree grows bigger you can increase the size of the ring and that is why it is given a specific name that is basing ring method which also comes into the same category of the Basin irrigation method, okay. Thank you with that we stop today, any questions?