Water management
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Lecture No 15
Irrigation Efficiencies and Irrigation Methods & their Suitability

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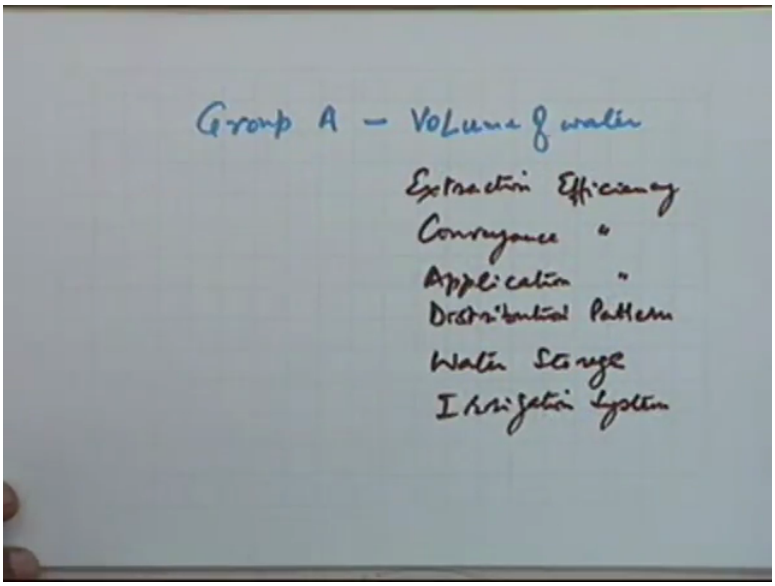

Okay in the last lecture we were discussing the irrigation efficiencies and we had club them into 3 different groups we had said that group A will look at those efficiencies which are dealing with the volume of water and we had gone into detail of defining these efficiencies, we had defined extraction efficiency, we had defined conveyance efficiency, application efficiency then distribution pattern efficiency, we had looked at what is storage efficiency. All these efficiencies were defining the indicators by which you can evaluate your system.

Looking at different losses for example the first 2 efficiencies were looking at the conveyance losses, the application and distribution pattern efficiency was looking at the adequacy of the application and then the water storage efficiency was also in the same category which was telling us about how effectively we have stored the water in the root zone and then the irrigation system efficiency was the total the end product or the efficiency which can include all these effects, so irrigation system efficiency we had mentioned that we can define that at any point of interest or at any location of the project if you look at the overall project then it will be called the project efficiency, if you look at the farm it will be called farm irrigation efficiency and accordingly it will be dependent on which location, at which point you are interested or which is your level of interest.

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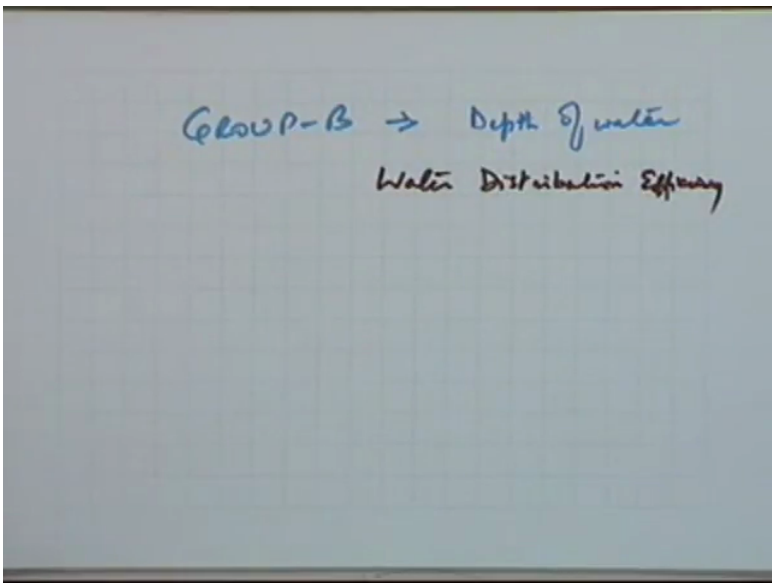

We had then gone in for the group B efficiencies where we felt that efficiencies which define the volumes they are not enough to ensure that the distribution in the field is proper because our main interest is to ensure that the field where you are growing the crop that should have a uniform distribution of water because that will satisfy the requirement of the crop in terms of removing the deficit which has been created through evapotranspiration in the crop, so this volume treatment does not ensure that or you will not know, you might have provided the volume, the required volume but how it has been distributed that is not known, so to incorporate those aspects we had defined another efficiency which is dependent on the depth of water and is defined as water distribution efficiency.

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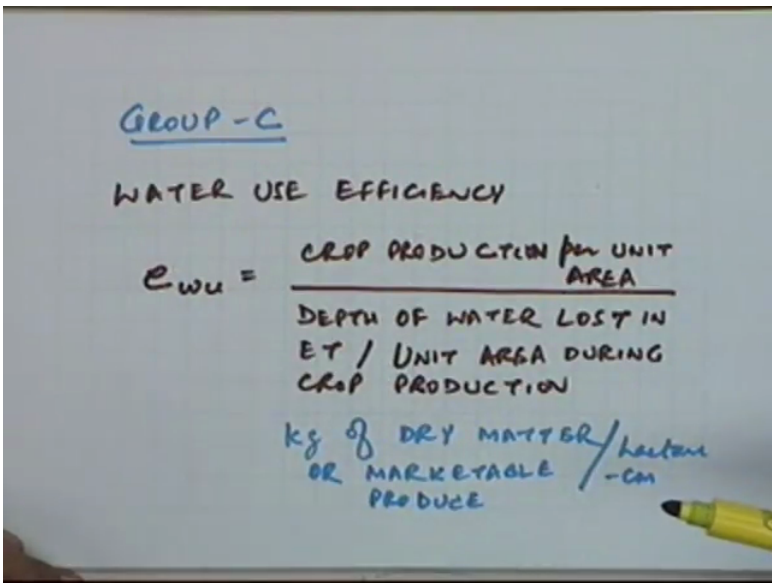

Now having done having gone through these 2 groups of efficiencies there was a 3rd group which we had defined in the beginning that there are some efficiencies which can be related with the crop production and some other related aspect which can be additional indicators to the farmers or even to the managers of the irrigation systems to find out how effectively they are managing their systems or for the farmers to find out how effectively they are managing their fields, so under the group C efficiencies we have the 1st efficiency will define is the water use efficiency.

Water use efficiency let us term it as e wu is the ratio between crop production per unit area to the utilisation of water in terms of the evapotranspiration requirements, depth of water lost in evapotranspiration again per unit area during the crop production. Now that will give you the effectiveness of the usage of water, how effectively the water has been used whereas your ultimate aim is to get the yield from the crop, now that usage of water which you have been supplying through irrigation should be evaluated or there is one way of evaluating that by looking at how effectively you have utilised that water in terms of getting the ultimate yield which can be in the form of marketable product or it can be in the form of…it will depend on what type of crop you talking about, if it is a green crop then it will be green but how much green you are getting if it is a vegetable crop, it will depend on how much is the production in terms of the vegetable of brought from the total field.

So it will be evaluated in terms of the kilogram of crop that will be the units in which it will be expressed kilogram of dry matter or even if it is some other crop can be marketable product per hector centimetre, this is the volume of water depending on how much area you are utilising and how much depth of water you have applied in terms of the total depth of the irrigation, so that much volume of water you have utilised in producing some amount of ultimate produced or the dry matter that will give you the water use efficiency.

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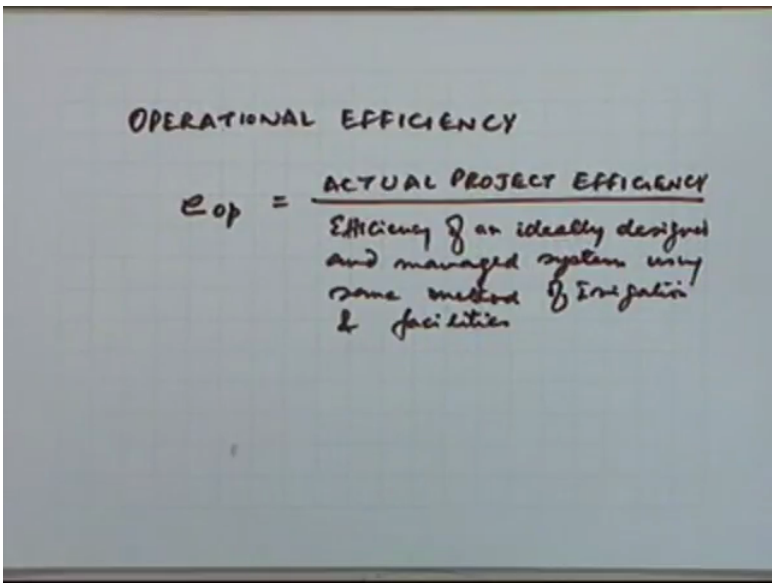

Then another efficiency which comes in this category is the operational efficiency. Let us call it e op, the operational efficiency is again another indicators which will tell the operator, it will give you an idea and indication how effectively you are operating your system, so is the ratio between the actual project efficiency to the efficiency of an ideally designed and managed system and there is you have to put a constraint because you might be able to get a manager system by using different resources and come out with project efficiency which is much higher than is not the idea you have to compare the comparable terms in terms of looking at the system if all the other resources are equal and only then you can compare with respect to the operational efficiency or the project operational efficiency, so you have to put a constraint using same method of irrigation and facilities.

So if you are using manure you should use similar manure and both the systems, so as to you can delineate the impact of the variation in the resources, so in this particular case now your question will be that what is ideally operated system what is ideally designed and operated system is very difficult to come out with a definition that which is the ideal one, it might be a subjective there might be lot of subjectivity because ideally designed and operated system is a matter of relativeness that you are comparing with something which is actually operated where you are trying to take all those management, you are trying to incorporate all those tools which you feel can enhance the efficiency for example let us talk in terms of the preparation of the fields, most of the loss which takes place in the case of irrigation is either due to the uneven distribution or the water going below the root zone which is a loss as far as the crop is concerned.

So if there is a deep percolation you will find that you have supplied more water than was necessary or if there is surface run-off again you will find that the water which was supposed to go into the soil, to penetrate into the soil has not penetrated into the soil, it has gone over the surface of the field and it might have gone as a waste, so these situations how they can be avoided, they can be avoided by proper design of the method of irrigation by the proper design in terms of the size of the field, in terms of the slope of the field all those things they are the tools or they are the parameters which are manageable, which can be looked at where the design can be made in such a way that you are looking at all those features and then you are saying that this is the best way of handling the system, this is the best way of laying the fields, this is the best way of…under the prevailing circumstances because all these things will depend on many factors and that we are going to come to that level immediately after this topic.

We are trying to look into which other factors which influence these efficiencies which you are trying to look at and that is what we are interested in, we are interested in knowing which is the best way of designing your system, which is the most appropriate method which should be used for irrigating the areas where you know the environment you know all the other parameters? So from that angle it may happen that there is under the similar conditions are 2 projects, in one project you are getting very high efficiencies, very high operational efficiencies, in other projects where you are not taken care of some of the things which are manageable, you are getting very low efficiencies.

So for that comparison because many a times you might not know that whether it is achievable or not, so just to make that happen this comparison or the definition of operational efficiency, it suggests that under similar circumstances a higher efficiencies are achievable. So that gives basic information to the managers of the system that since those things are achievable they can click onto their system they can look into their various aspects of their systems and come out with some alternatives.

They might be able to isolate those, in point those problematic areas whether it is in the form of distribution of the water or whether it is in the form of forming of the land, in the fields, all those things can be looked into and they can come out with some alternatives or some measures by which they can enhance their efficiencies and that is the idea of defining such an operational efficiency but it is a relative thing that you had to understand that it will remain relative, you might come out with a ideally designed system which can be can also be

improved upon, so there is no such fixed thing that there is only one ideally designed system, you are approaching towards that you might keep on approaching towards that state where you feel that you have achieved the most optimum system.

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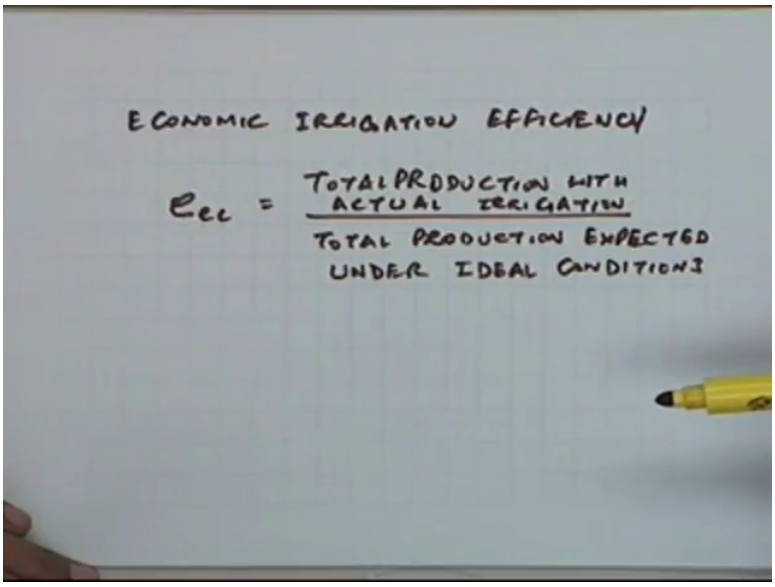

Next we will look at another efficiency which can also give you some indication and it has the similar philosophy is called the economic irrigation efficiency. Let us call it e ec as the ratio between total production with actual irrigation to again a similar thing the total production as we have consider in the previous case because you have to compare it with something expected under ideal conditions. In this case again what you are looking at, you are trying to look at what yield you are getting from your areas and what is the achievable under similar circumstances, what has been achieved elsewhere?

Normally you will find in every country the intention of the local government will be to have the agricultural Universities because these conditions keep on varying, you might be able to have the same variety of crop in one area it might produce a different results in another area when the environment changes its behaviour will also change, its yield will also be affected, so you cannot compare a crop which is grown in Punjab with the crop with the same crop if it is grown in South, their comparison might not be true comparison, so unless you take an area which is having similar environment, similar conditions and to certain extent maybe similar soil, when you say environment it will also include the other characteristics like what type of soil you are having.

So if you if you can compare the produce or the yield under similar conditions and then you find that yes there is lot of difference that is what can be done under the university environment, in the agricultural universities they have all the methodologies available, they have all the resources available, they can show people that this is what can be achieved and since they are they belong to an area which they represent, so at least in that area the conditions are similar, they can say that if this can be produced here under our conditions of which are conditions which where they have managed the things very well then it can be done elsewhere also, so from that angle this efficiency is as incentives to the farmers.

You might have heard that the agricultural universities they keep on having the annual fare where they invite the farmers, they invite the farmers from their own region and then they show them that the crop which they have grown, how good it has come and what is the expected yield? They can even report the yield which they have obtained and then they discuss with the farmers that what they did to achieve this? What were the inputs? Whatever the inputs beyond the artificial inputs in terms of the manure? How they manage their irrigation? What were the timings when they had irrigated they are areas? Which other more crucial stages in their crop growth which should be taken care of?

So all those things if the farmer can be shown that, yes it is possible, it is achievable then it is an additional incentive to the former and with those intentions these types of efficiencies are they are defined and they can be used for the enhancement of the overall production because once he goes back he will try to look into where he went from? What was the reason of his getting the yield which is much less? Which might be in some cases it can be half the yield which is achievable, so those are things which work very well and with that intention this is all these things are defined and they can be used to design the systems or to even relook at your systems and come out with some alternative adjustments in your system which can improve your the functioning of your system.

Now with that we have defined all the possible means there are many other efficiencies but these are the major efficiencies which can be considered by the farmers, by the designers, by the managers of the irrigation systems and they can make use of these efficiencies. Now having known these efficiencies it has given us additional advantage that when we go to the next level of designing our irrigation systems or looking at the methods, which methods of irrigation we should use? We will have in the back of our mind that why, why this method will not behave very well? Why this method? What is the reason that this method will be a

poor performer under the given conditions? So you will buy the end of your this course you will have a feeling that looking at the conditions, given the conditions you will get a feel what is the methods, what is the best method under the circumstances which should be selected for a specific area under specific conditions.

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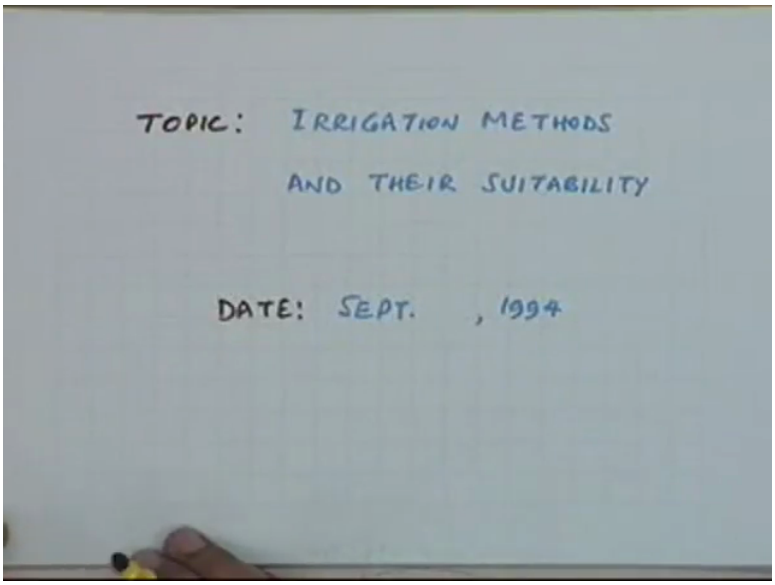

So with that we start the next topic which is the topic on irrigation methods and their suitability. Is there any question on the previous topic which we have covered? When we think of the irrigation methods what is the need? First of all why we want to look at the method? You will normally find that if you do not if you are not careful about how you apply the water.

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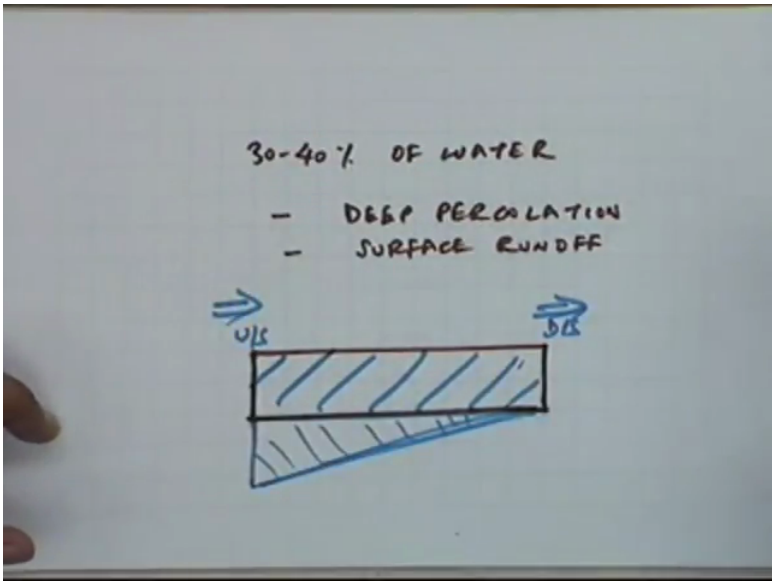

The general feedback is that up to around 30 to 40 percent of water might get wasted in the form of either deep percolation or surface run-off. So in order to avoid these losses, there can be some other losses also, you want to use those methods which can reduce these losses, these losses plus any other loss, there can be losses due to depressions which are formed in the field, so if you have a field if you know that this is the upstream and this is the downstream end of the field, you know that this is the requirement you require to supply or to replenish this much deficit which has been created.

Now you want to replenish this deficit and if you choose a method which helps you in replenishing this this deficit by supplying this much water then we have seen earlier also that this is the waste, this is the waste due to deep percolation. If your supply of moisture which you are…the water which is supplied at the upstream end, the rate at which is getting infiltrated into the soil that is much less than the rate of supply then you might find that some of the water might go beyond this downstream point of the field and that will be the surface run-off. So both these losses there are many factors which influence these losses because these losses are because of the fact.

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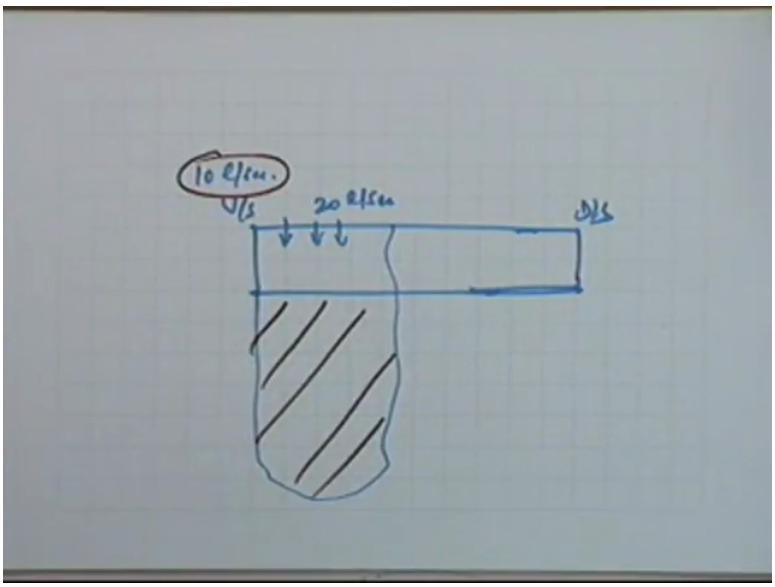

For example let us consider that if I if I have same thing I will put again here, this is the field this is the requirement upstream point, downstream point, now if I supply water at a rate which is for example let me say 10 litres per second and the infiltration at which can occur, it can infiltrate into the soil the infiltration rate or the infiltration capacity which is prevailing because of the type of the soil you are having that is 20 litres per second. It can infiltrate into

the soil at 20 litres per second rate, you will find most of the water which is being supplied will get absorbed and will keep on going down.

At the same point it might not have any amount which is which can travel in the forward direction, so if that happens then you might find that after a long period you might have collected something like this, this much water has being collected this much water has been infiltrated and you could cover only a very small length of the field, so the wastage is very high in this case this whole thing has gone waste whereas you could not get any water in the field beyond this level, so what has govern that the soil properties? One, the rate of application the stream size are the one or similarly there are many other factors which will decide how the water will be moving in this particular field.

So you will have to first look at all those factors, all those characteristics which can influence the moment of water and only then you can go to the level of looking at the various methods because those methods have come through experience as we are our ancestors have been cultivating areas since ages and they have learned earlier nobody use to teach them, it used to come just with experience the experience will pass on from one generation to the next generation, so some of the methods which we are going to discuss, they are age old methods, they are conventional methods and they have the wealth of experience behind them but we can give them scientific level of understanding we can improve upon those methods by looking at what exactly is happening in the background and in certain cases there are some additional corrections which has been applied to those methods so as to make them more appropriate, more beneficial to the farmer.

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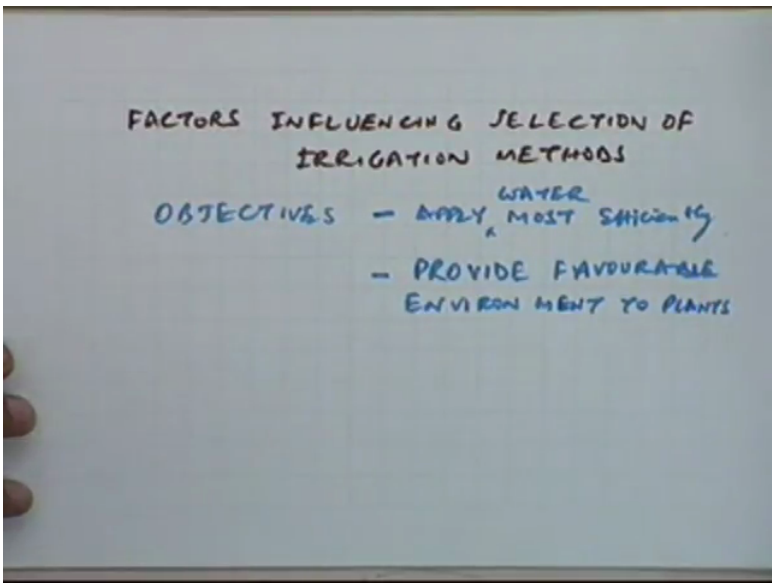

So let us first look at other factors which influence the selection of irrigation methods. You might say that we do not know which irrigation methods we are going to discuss or talk about but that is not necessary at this stage. We are trying to look at the factors in a general manner, which are the factors which will influence the any method of irrigation irrespective of which method we will look at. It is the fact like here we have said that the rate at which water is going to be supplied is one thing which will decide that how the water is moving within the soil.

Now the method subsequently will come to those exact methods which we have in practice which are being used by the farmers in general but these factors which we are going to look at they can be tackled even before looking at the specific methods which we are going to deal with because in all these methods if we look at what are the objectives, what are the objectives we have? We want to apply the water most efficiently and there is one aspect is the first objective that you want to ensure that there are no losses beside this the selection of the methods will also be influenced by…are we providing a proper environment to the crops or to the plants, so the second objective in doing all this what will follow in terms of the selection of the methods or in terms of the designing of the methods will also look at that we want to provide favorable environment to plants.

So with these 2 major objectives is not only the efficiency which is important because you might have applied the water very efficiently but if the conditions which you have created by doing so they are not very conducive to the growth of the plant then you will have to ensure that you should look into the conditions also for example there can be some plant which need

more irrigation, so if you try to bring the conditions to a level where it is close to saturation and that persist for long time then the crop will have a very bad effect as far as its growth is concerned because it can be growth can be much better if the irrigation is there, so if the moisture conditions can be kept at a lower level, so all those things are include when we say that favorable environment we mean by that that you will have to look at which is the environment under which the crop growth of that specific crop which is under which is the target crop, which is that environment which can be more suitable, so you generate that environment while selecting the method, if you can do that then you crop production can be much better.

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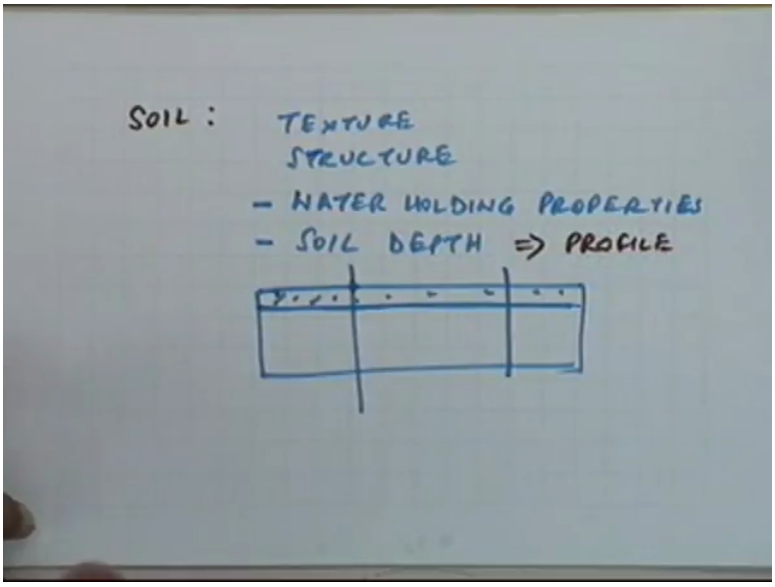

So with these objectives the factors which influence the selection of irrigation methods the first factor is the soil factor, the soil is the major factor which influence the methods to a very great extent and the various aspects of soil for example texture, structure of soil. The texture of soil as well as the structure of soil they will influence the integrates like the texture will decide what will be the infiltration rate of that particular soil, similarly structure will influence the ease with which the water can pass through the soil. If your texture is such that they are fine soils in that case the infiltration rate will be very low, so in that situation if you will try to supply lot of moisture on top of the soil it is quite obvious that you might lose this water in the form of surface run-off.

On the contrary if you have light soils which are sandy soils you will find that the infiltration rates are very high, in that situation you will lose lot of water if you are not careful if the opportunity time is… because at any stage let us discuss this point which is important that

when you are talking of this field, now the amount of infiltration which is taking place at any section, if I take any section at this level, the amount of infiltration which takes place as a function of for how long the water was available at this point on the surface, so that is what you call the infiltration opportunity time and that is going to decide how much will be the infiltration which has gone into the soil and that will be decided by many things one what are the slopes of the field? What is the rate at which the water is being supplied?

These are the 2 major factors which will decide that how much is the opportunity time which has been observed at this particular level of the field. Similarly at some other level the amount of water which has infiltrated to the soil will be a function of for how long the water was available at the top of the surface. So the texture, the structure will be the major influence on the amount of infiltration because they are other ones these other 2 properties which will decide what is the infiltration rate.

Then you have even the water holding capacity, the water holding properties are also decided by the soil type because the water which you have supplied at the top of the surface, out of that how much can be retained in the soil is a function of soil characteristics and that in turn will decide for how long you can wait for the next irrigation, so all these things are interconnected because if you know that the soil is such, it has it has water holding capacity which is very low then for that soil you have to have a method which by which you can ensure that you come back to the same field before a time which is less than the time which it takes to deplete the moisture level below the desired moisture level, so that has to be ensured then the other properties of soil which can influence the irrigation method is the soil depth. Was the profile also soil? This is also…when you say profile you mean that what is the extent of the soil available at that particular location.

Now how this factor, the soil profile effects the irrigation methods, what happens is that if you are let us take an example that you have soil profile available in an area is a shallow soil, the extent of the soil is not as deep as it should be, so in that situation if you go in for the land forming, it is not a very plane areas and it is undulating areas and if you go in for land farming, land farming is that you want to shape the land, you want to level the land in such a way that you can ensure the moment of water over the surface in a proper and in a uniform manner. So if you go in for the land farming the cuts which will be made in the soil, they might be excessive and since this soil is already shallow it might expose those soils which are not fertile soils. In general you will find that the top soil, the top portion of the soil will be

more fertile than as you go deeper into the soil, the soil will be less and less fertile and most of the time the organic matters which are available in the top layer of the soil and even the other minerals which are there you will not find the same as you go deeper into the soil.

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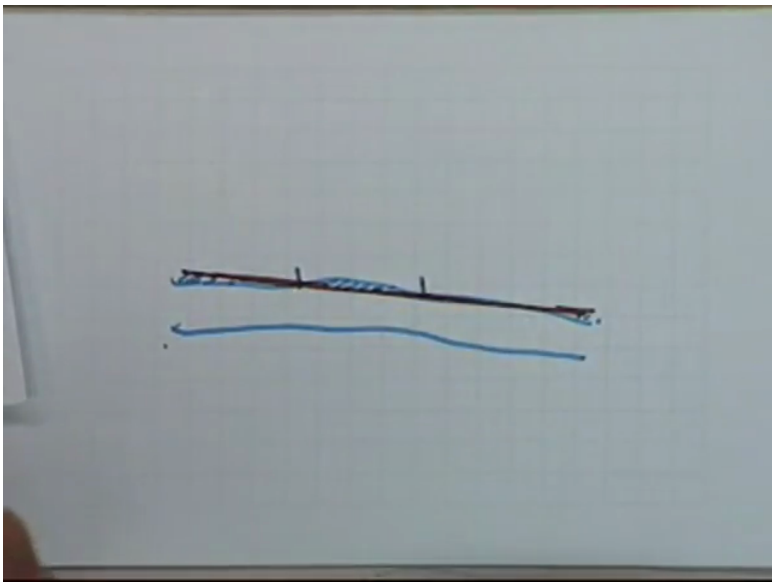

So the fertility of the soil is much higher in the top portion and when you go in for if you have an area which is undulating area and you have the depth of the soil is also the profile of the soil is that you do not have a very excessive depth of the soil. In this particular case you go in for a land forming you might like to get a get some proper grade of the area remove these undulations you might like to get this grade and this what you have done you have removed the soil from this, you have dumped that soil somewhere here, so when you have removed the soil you might have exposed the soil in this zone, the lower soil has been exposed we have lost the fertile soil, so those operations which are land forming operations they are restricted when you have a very shallow soil and you may not be in a position to use the methods which you feel they could have been used if the soil profile was sufficient enough.

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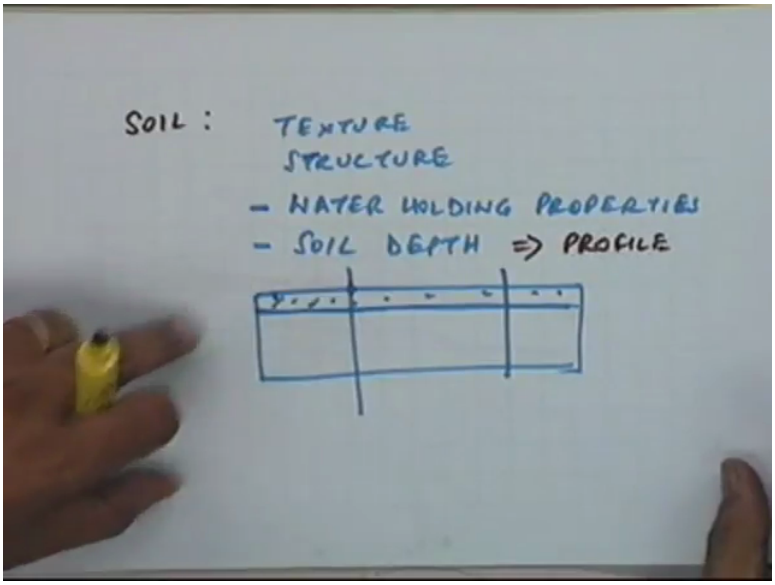

So this is what when we say they soil depth influences the method of the irrigation that is what we mean, okay.

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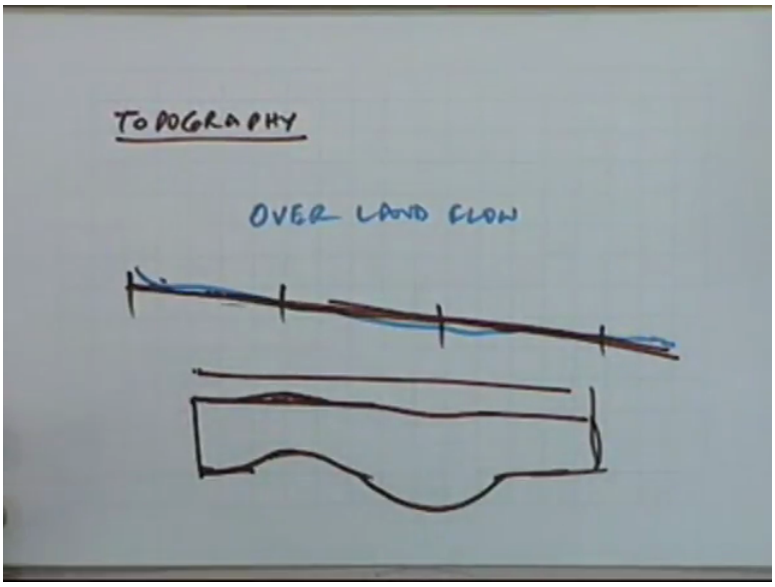

Then the topography is another parameter which can influence the method of irrigation, which method of irrigation you can select? How it can influence basically if you look at the basic aspects of how the land the overland flow this component, it gets produce in the area, this will be a function of what are the prevailing slopes available in the area, so if you are prevailing slopes are search, the general slope is something like this even if you try to form the areas and get a general slope still the slope might be quite excessive to produce higher rates of run-off.

If you have divided this into different fields still in each field the slope is such that it will generate run-off, so you might not be in a position to use the methods which need more opportunity time, if you want to if you are soil conditions are such that you have a heavy soils, you might not be in a position to use a method which just let the water move from this end to this end and the opportunity for that water to go into the soil will be very less before it reaches the downstream end.

So in this way the topography can sometimes it can be the major factor which influences the methods of irrigation which can be used for example if the topography is still very highly undulating you might not be able to use any of the surface irrigation methods, you might go in for method which is closer to either it is sprinkler irrigation method or drift irrigation method but these are not this is not the only condition which it will influence that whether you can use that drip or sprinkler irrigation method they have together conditions which have to be looked into in conjunction with this one factor and only then you can decide but the topography can play a major part.

Moreover if you do not, if your topography is such that there are undulations and you have not formed those areas properly, there are some depression which are still left in to the fields then what will happen? You will have in some areas of the field you will have more water than in other parts. Suppose if this is the field and in this field when you are supplying water, this is a low-lying area, when you are supplying some water the water might get blocked into this (())(51:33) whereas the other area or if there is some other area which is having the hump, now that area might get much less water, so the topography if it is having some undulations and you have not taken care of those undulations by proper grading of the areas, it can create lot of problem.

So in that situation again you might not be able to use a method which lets the water move from this end to the downstream end at rate or with a depth which is very small depth that method might not be suitable here. You might have to use a method which can allow the water to gets stored or some specific time so that the water can move and all these areas at some rate may be still there will be a chance that this area might get much less water in terms of if you look at the total depth of water made available. This might get much less infiltration depth than this area, this area since there was a depression it has got more than what it wanted it was desirable for this particular location, so that way the topography can be can play

important role. So we will stop here and in the next class we will look at the other factors before we go onto the various methods which we have in practice. Any questions?