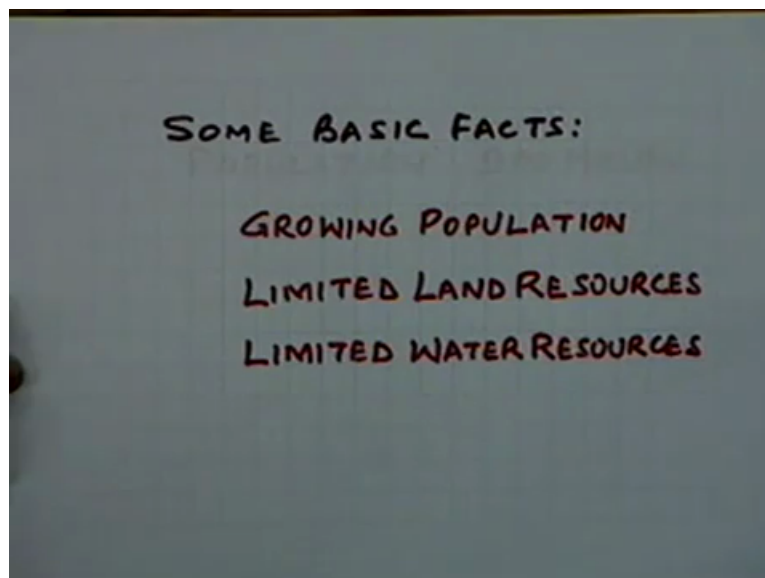


Water Management
Doctor A. K. Gosain
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Lecture 01
Introduction to Irrigation Water Management

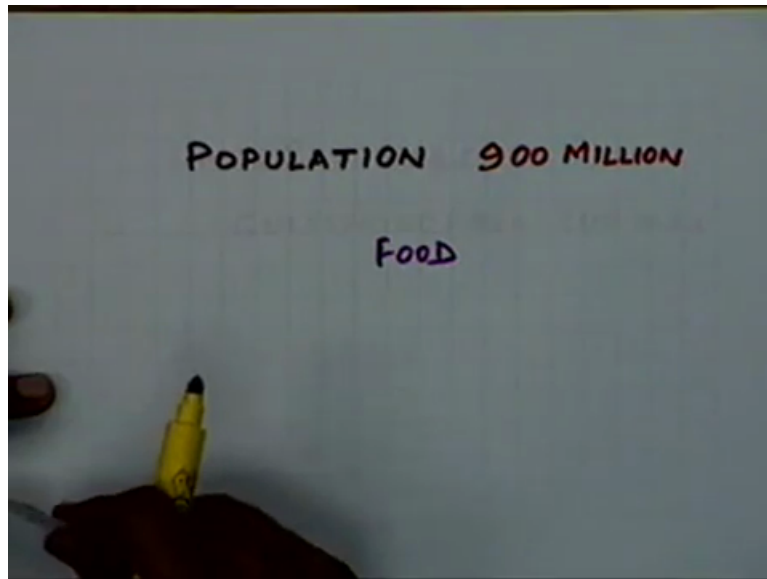
We are starting with the subject on irrigation water management and to start with the basic introduction to this specific topic we will have to look at some basic facts. Now there are some of the facts which are true for our country and in general they are true for any other country also that every country there is a problem of growing population, the land resources are limited, water resources are also limited. So within these constraints you will find that the need for irrigation water management is there and that has to be brought out.

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We will tackle these things one by one. First looking at the population, if we talk in terms of our own country, our population is already 900 million and when we say 900 millions is only second to China which is the most populated country. Now the question comes that to cater to the food requirements of such a populous country you need lot of food. So when you see that population is such a high figure you have the requirement in terms of food.

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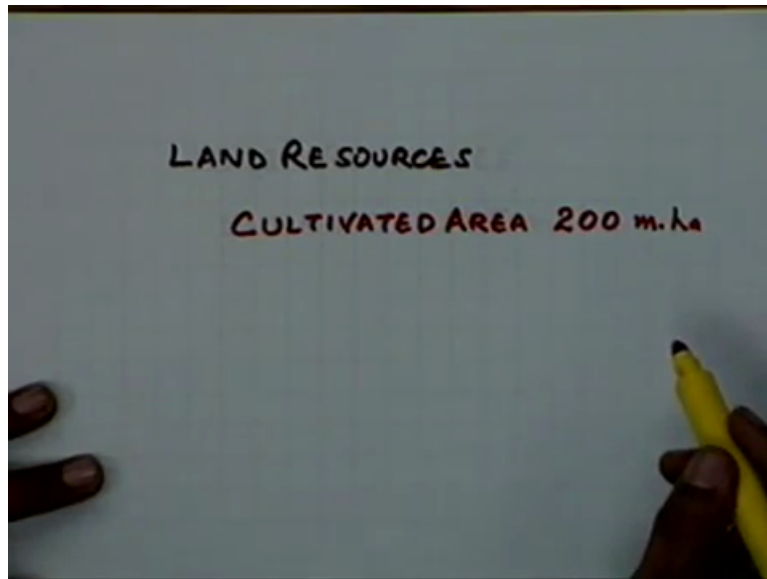


From where this food will come? This food will only be produced through cultivation. And to go in for cultivation you need the land resources. In terms of cultivated area though we have with lot of efforts over the last around three decades, we have improved in terms of the cultivated areas. We had cultivated area which was to the tune of around 110 million hectares and we have come to a level of 200 million hectares through bringing in more area which can be cultivated.

When we talk of cultivated area it is not possible to bring in many areas under cultivation because of varied reasons. Those reasons will vary in terms of the topography. If you have a difficult terrain, the topography is so difficult that you cannot cultivate that area or you have unsuitable soils. So all those things they are some ways and means by which you can bring in some of these areas under cultivation and that is how we have been able to increase some of these areas.

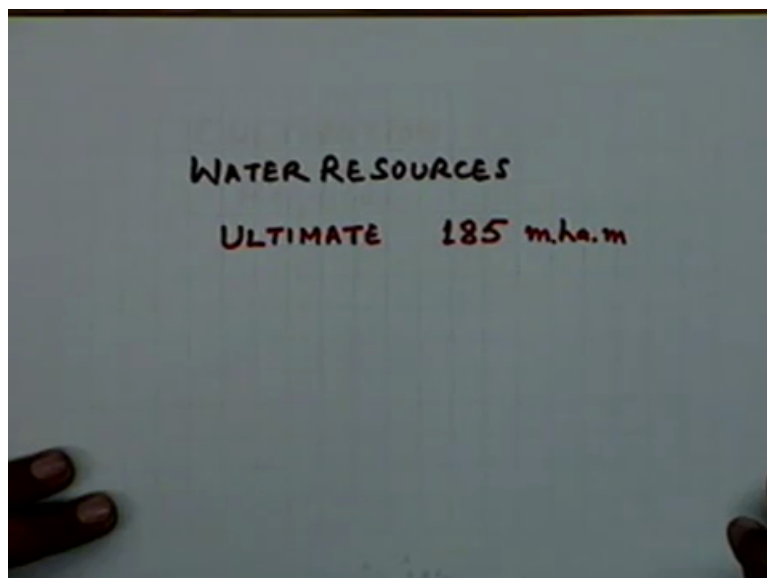
But some other areas are very cost ineffective or they cannot be justified to be brought in the cultivation because the cost are so enormous, it is not possible. So when you talk of cultivated area, there is an upper limit and in the case of Indian context the upper limit might be slightly more than 200, maybe 240 million hectares.

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But there is an upper limit. You cannot afford to go beyond that limit. So as far as the land resources are concerned we again have a constraint, we cannot keep on increasing the land under cultivation with the increase in population. So if the population is increasing the land resources are limited. So we will have to adopt some other means by which we can improve the crop production. There is another very important component which is needed for the cultivation of food or the production of crops and that is water resources.

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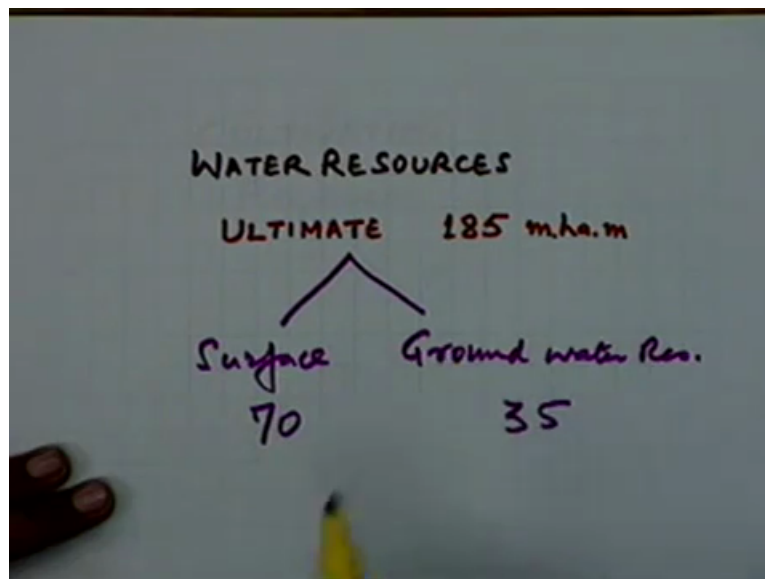


Again when we talk of water resources there is an upper limit up to which you can tap these water resources. The ultimate limit for these water resources in terms of Indian water

resources we have around 185 million hectares metres. And this is composed of two components. We are having surface water resource and ground water resource.

So this is composed of surface water resource as well as ground water resource. Presently if we look at the figures, the statistics, we are utilising around 70 million hectares metres of surface water and around 35 million hectares meters of groundwater.

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So in terms of the ultimate and the present utilisation there is a big gap that can be filled up by utilising the latest technology, by having more places where you can tap these resources.

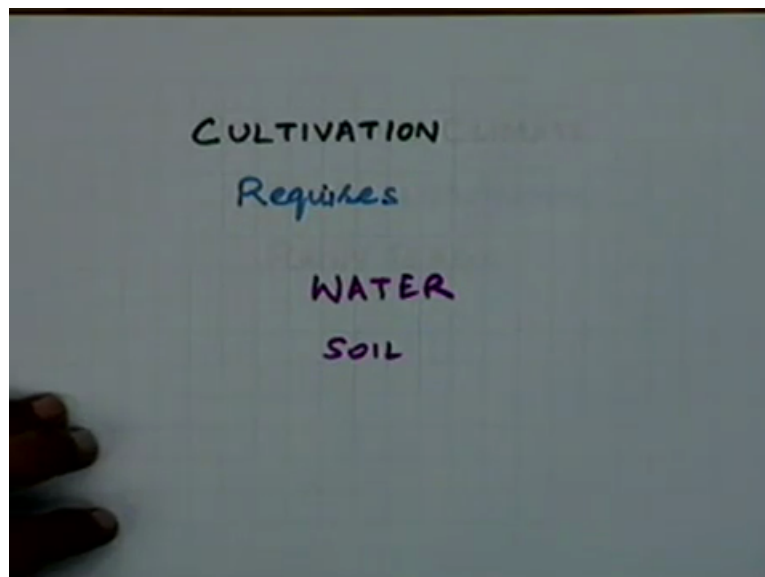
Because when you talk of water resources it is not the availability of the water which is available because of the rainfall occurring over the total country but it is because of the fact that at that time when you need this water is it available and that availability is created through creation of storages either in the ground or on the surface in the form of reservoirs, in the form of tanks. So that is where the water resources, when you talk of water resources that is the constraint on the water resources.

The utilizable water is that water which is stored in some form so that it can be tapped when it is required. Now coming to the next thing that we know that we require cultivation. We know that the requirement is growing with the growth in the population. But let us look at for going in for cultivation what do we require? What is the need when we go in for cultivation? What the cultivation requires in turn?

If we go into the major items which are required when you go in for the cultivation, the basic thing is that you require water for cultivation and you also require soil which serves as a medium to supply water and salts to the crop for its production. But it is not the amount or the rate at which the water is required. That is what is the major aspect which has to be looked into. It is not the quantity in total and this is the quantity which is required and if you supply this quantity that will take care of your problems is not true that way.

It is the water in quantity as well as in distribution that when it is required and how much it is required both the things are equally important. So when you talk of cultivation we know that is highly dependent on what is the distribution of water and what is the quantity of water which is available.

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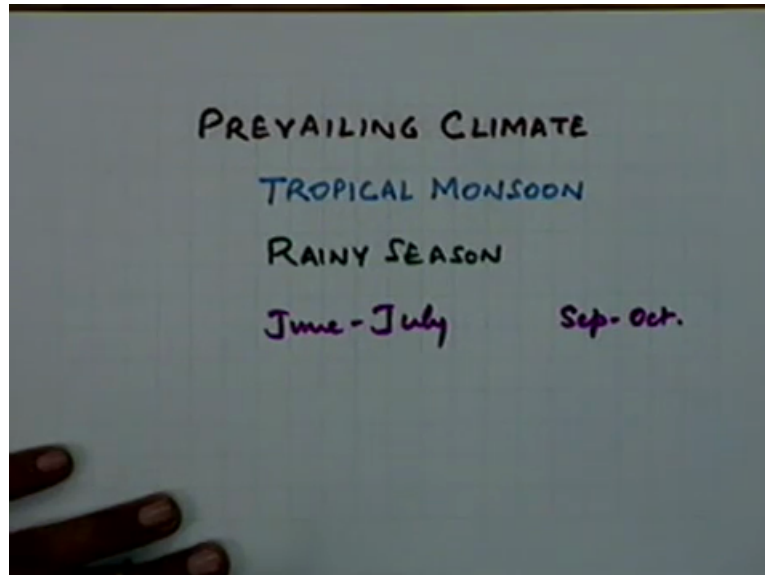


That is why in earlier days when the farmers used to cultivate its land he was totally dependent on the natural precipitation or the natural rainfall. If the rain comes in proper quantity as well as in proper spatial distribution or at proper intervals then his crop used to be quite reasonably good. But if the quantity or the distribution fails then the crop will have some detrimental effects or it can even fail altogether. So the reason behind this particular effect is because of the prevailing climate.

It is the prevailing climate of a place which will influence the crop production and when you look at the availability of water you will have to see that in conjunction with the prevailing climate. Now if we look at our own climate, the Indian climate, we have tropical monsoon

climate. We have a very well defined rainy season which is spread over 4 months. It varies basically from June to July and goes up till September October.

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So this period is the monsoon period for most of the country. But as you know India is a vast country there are some areas which are not covered with the monsoon pattern for example Tamil Nadu. It does not get much rain during the monsoon period. On the contrary they get rain during the winter period. It is called winter monsoon and they get rain from October to December.

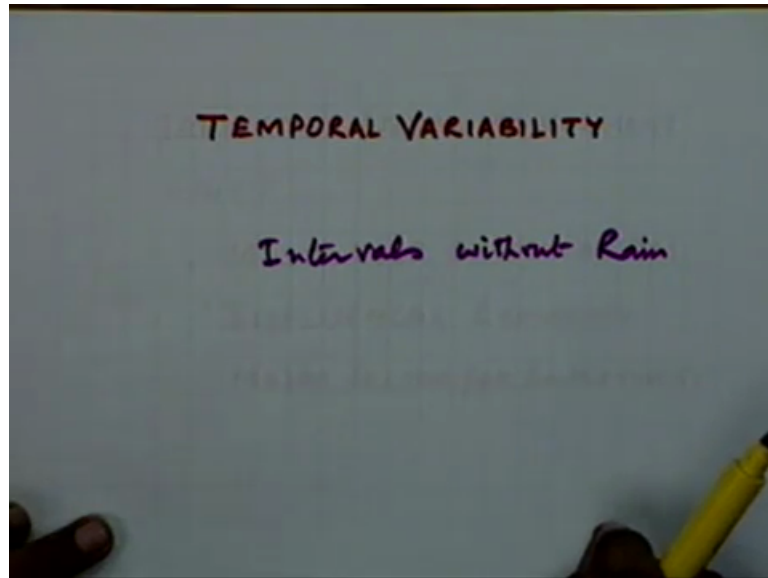
Then besides the concentration of rain in these 4 months that creates a lot of temporal variability because a rainfall it is concentrated in around one third of the year and all the rain comes during that part of the year. So consequently only those crops can be grown with the natural rainfall which has their growth period matching with these monsoon months. The other crops if you want to grow you will either have to depend on the moisture which is retained in the soil or you will have to provide additional moisture.

So the temporal variability that means the variability of the precipitation in time, that is really very large. It is not only the monsoon month and the non monsoon months, within the monsoon months also you will find that in some areas there is some temporal variability. That means you might get some intervals without rain and these intervals are quite significantly large that they can be detrimental for the crop production.

Because if the rain, part of which it is stored in the soil and if the soil is depleted before the next rain comes then the crop will be affected. So that is where if you have interval between

two rains which are large enough to let the moisture be used from the stored moisture in the soil then there will be some effect on the crop.

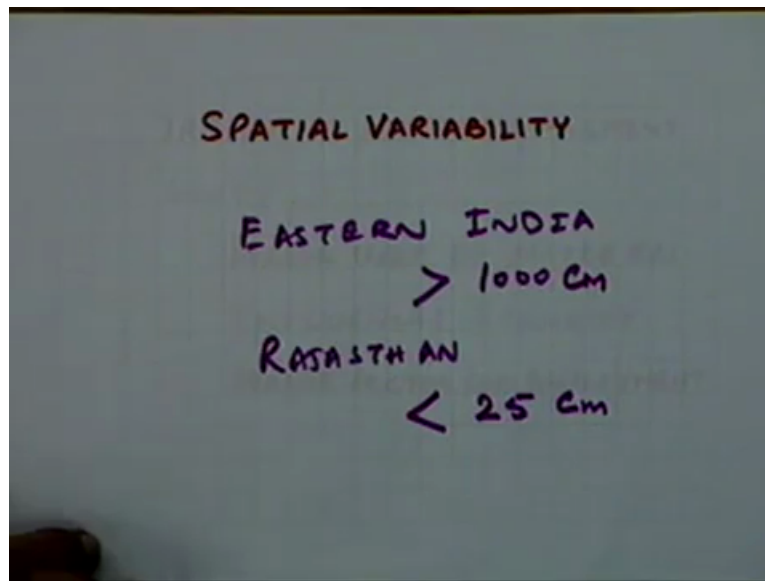
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So that temporal variability is also one reason that why you need supplementing the water in the soil through some means and one of that is irrigation and that has to be taken care of. Then the other aspect of the climate is that we have lot of spatial variability. Again if we look at our own total country as a whole you will find that the rainfall amounts they vary from one area to another area. For example if you talk of eastern part of the country you might be having rainfall even more than 1000 centimetres at some places.

For example Meghalaya has the average rainfall is more than 1000 centimetres. If you talk on the other hand of some areas of Rajasthan you might have rainfall amounts which are experienced over the year even less than 25 centimetres.

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So the spatial variability also is very large. The quantities are not uniform over the whole country. There are some areas which are very deficient in terms of rainfall, there are some areas which are surplus in terms of rainfall but you will see later on that after a particular level that surplus is of no use as far as the crop production is concerned, it is a waste, okay. So from that angle when we talk in terms of the availability of rainfall we have to talk in terms of its spatial and temporal distribution also.

Now coming to the next question which will come obviously in your mind that having established that there is some need for irrigation because we want to irrigate the areas because of the fact that to cope up with the spatial variability irrigation water. These are some of the major reasons why we need to manage our irrigation water properly. First one is that the irrigation water is required to take care of our agricultural sector in a proper manner and agricultural sectors in turn has the major user of water resources.

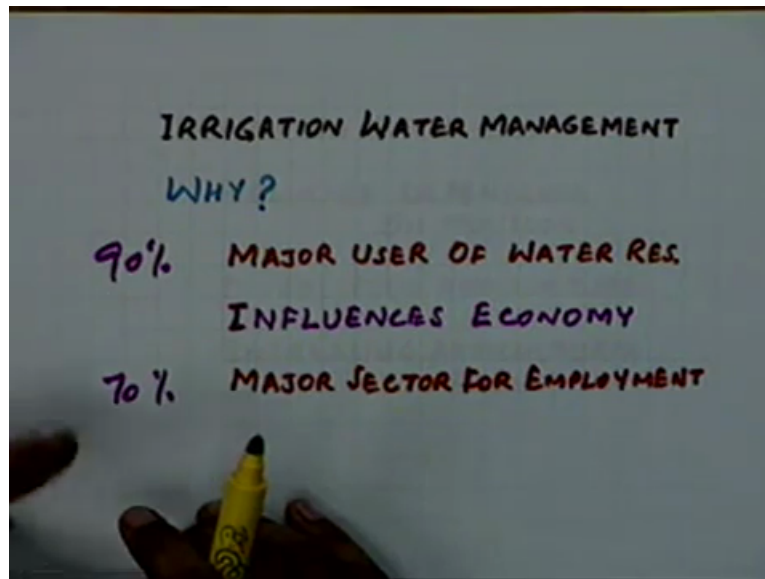
If we look at our total water resources utilisation agricultural sector may be using something to the tune of 90 percent of the water resources, the other 10 percent is only used for the domestic and industrial usage. The major user is only the agricultural sector. So if there is any mismanagement of water is going to influence the total economy in a very big way. There is a reason that it influences the economy also because we are basically agricultural country.

So our total economy is agricultural based. If you look at your Gross National Product, the agricultural sector contributes around 40 percent to the GNP. So from that angle also we must look into the management of this particular water which is needed for the agricultural crop

production. Then this is the sector which is the major source of employment. If you look at the working population, around 70 percent of the working population is employed in this agricultural sector.

So from that angle also this calls for a lot of attention and we must try to look into the management of our irrigation water if we want to enhance our crop production.

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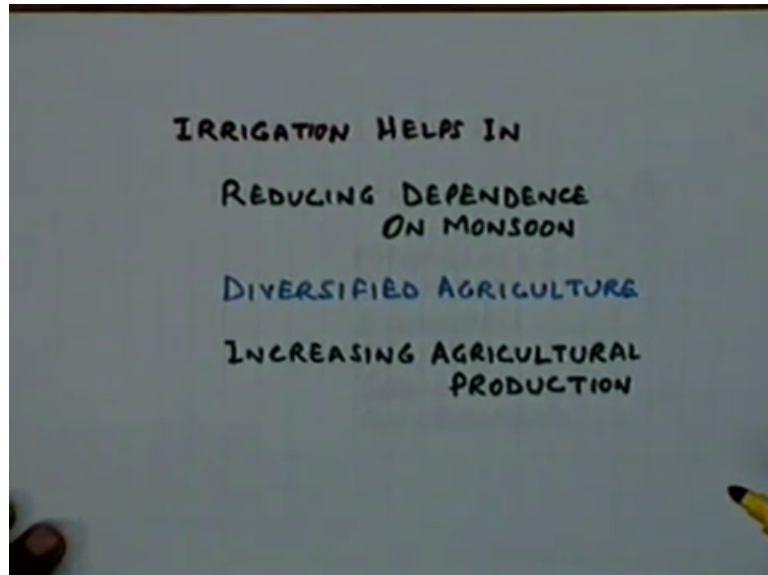
It is the irrigation which helps in the crop production. It helps in these many ways. It helps in reducing dependence on monsoon even if the monsoon is erratic as we see that it is erratic. From year to year there is a lot of variation in terms of spatial variability as well as in terms of temporal variation. So to reduce the dependence on monsoon we can use the irrigation. Irrigation helps us in reducing the dependence. Once you have the assured irrigation you can also go in for diversified agriculture, okay.

You can grow some of the crops which are suitable for the area and which might be quite sensitive to water availability. On the contrary if you grow the crops in those areas where the irrigation is not assured and you go in for some sensitive crops you might face total failure of the crop because you do not have any water to supplement the irrigation. Then it is also helping you in increasing the agricultural production.

If you compare those areas where you are doing the farming or the crop production is not having any support from the irrigation, is only dependent on the natural rain and with those areas where the irrigation facilities are there you will find that the agricultural production is

around 2 to 3 times more than the production from those areas where the irrigation facilities are not there.

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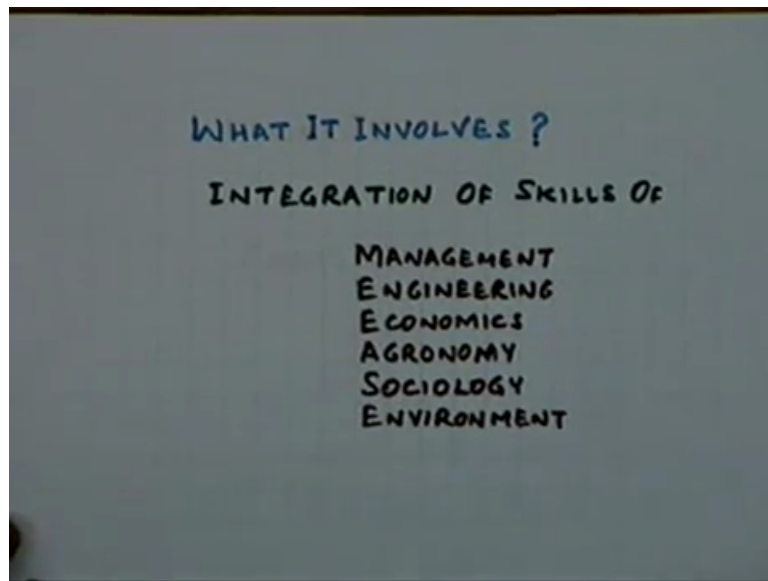


So irrigation has a distinct advantage and there is another reason that why we should try to look into the management of irrigation water. Now next let us have a look at the irrigation water management, what it involves? It involves integration of many of these different facets that is management irrigation. You have to use the skills which are developed in these areas and integrate all those skills so as to increase the crop production. That is the final aim.

So these different areas they can be management, engineering, economics, agronomy, sociology, environment. Environment has become now in the last decade the environment has taken lot of importance because it has been felt that we are indulging too much into the nature and in many cases we are doing more harm than the advantages which are accruing through those changes which we are making whether it is the irrigation.

Because irrigation is again artificial man made activity and it has its own problems. So it is essential that when we talk in terms of water management you must look into what harm we are doing to the ecology so that those can be avoided and that is also has become the part of the management.

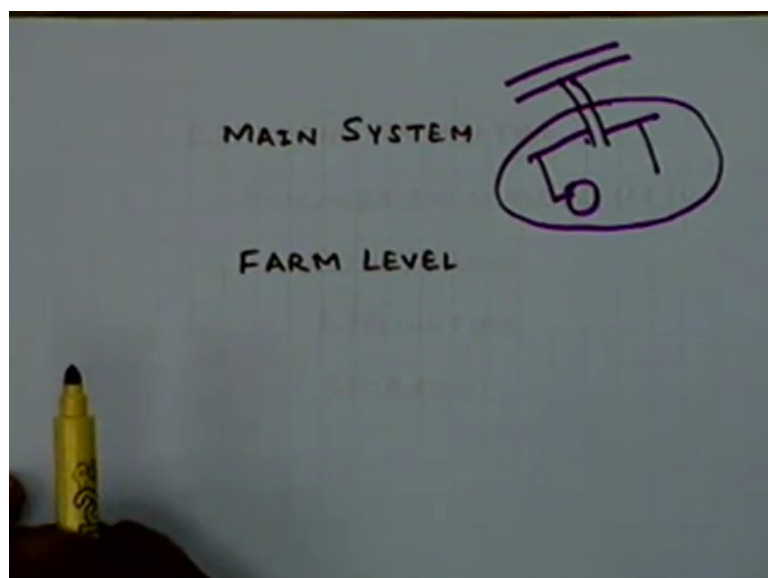
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Moreover there are many other areas and when you talk of water management it is a very vast subject. If we look at irrigation project we can divide the irrigation project into two main segments, one is the main system. The main system involves the distribution system of water. If this is your project you might have taken this water from a river, tapped it from there and brought it through a main canal.

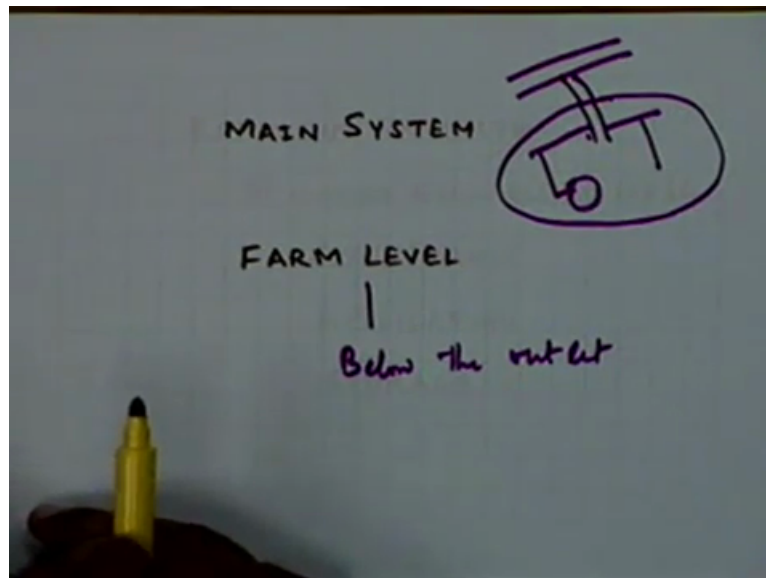
The main canal has its own distributary, a distribution network and this network contains the distributaries minals and subminals and the total network. Only after this network you reach area which might be the area of your interest where the water has to be taken and that area is the form area or sometimes you refer to this as the below the outlet.

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So it is the command area of the outlet, the different names, that is the level in which we are interested for the time being. We are trying to deal with that level, the on farm management. So the irrigation water management from the point of view of on farm management, we will not be touching the other area of the main system, okay. So we are confining ourselves to the below the outlet.

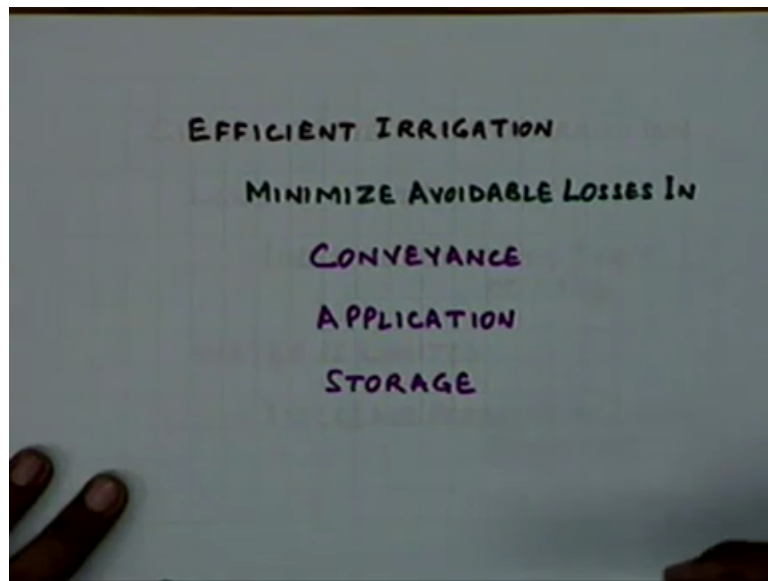
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We know that the one major component of the irrigation water management is to go in for efficient irrigation. There are some other areas also which have to be looked into but the efficient irrigation is one aspect which needs major attention and it involves in (mini) minimising avoidable losses.

So we see that we are going for increasing the efficiency of irrigation what we imply is that we want to reduce the avoidable losses and these avoidable losses reduction is in turn at these three levels while conveying the water, so the conveyance losses which are present if you can reduce them then we are saying that we are effectively doing the effective irrigation or while applying this water, the application and the storage of this water in the soil.

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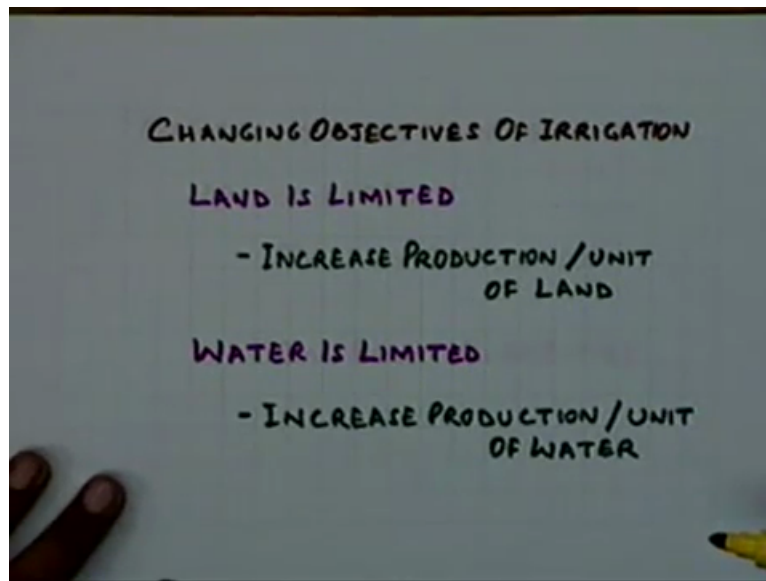


So these three are the sectors or the broad areas in which we will try to go into the depth so as to know what are the specific areas where you can have some impact on the reduction of losses. Then at this stage I will also like to mention that the irrigation does not have very set objective. There are conditions under which your objectives of irrigation might change as well, okay. For example there are two conditions which I have just mentioned here.

Suppose you have a situation where land is limited. You have limited area which can be brought under cultivation though there is no restriction on the availability of water then in that situation your intention will be to increase the production per unit of land. So you go in for intensive irrigation. You go in for intensive cultivation. That situation you will find in such areas where there is lot of rainfall and even in the case of the monsoon period you have lot of rainfall.

Whenever there is some shortage of water that can be supplemented through irrigation but the land is restricted, is limited. So you will try to go in for those crops which give you the maximum production and there might be need in more water, okay.

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Whereas, the other situation can be where water is limitation so the land might be available but you do not have the water. So in that situation your aim will be to increase the production per unit of water so that you can make use of the (35:09) available water in such a way that your production is again maximized. So it is not true, you cannot say that the irrigation has the same objective. The objective can change.

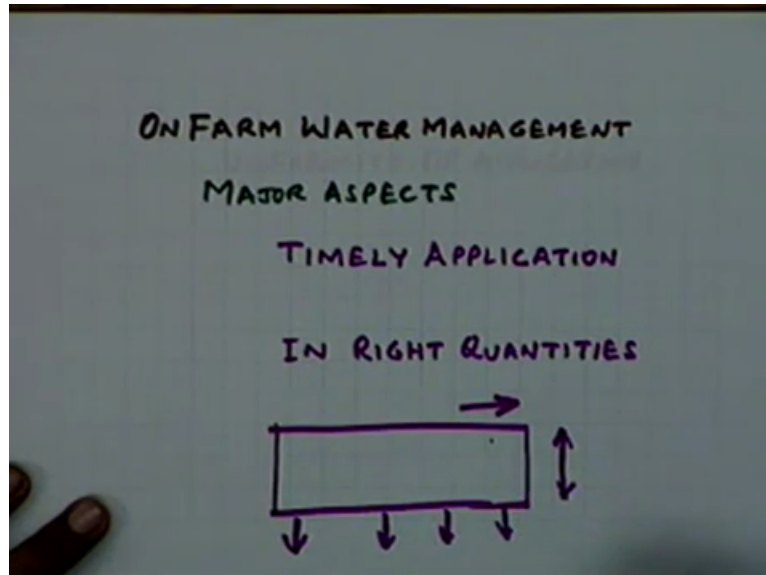
That is where you have to look at when you do the planning you have to look at all these aspects and then decide whether you would like to go in for intensive irrigation or you will like to go in for extensive irrigation, okay. As I mentioned earlier that we will be more interested in or we confine ourselves to on farm water management and the area of on farm water management there are three major aspects which should be covered. First is that you must ensure that the irrigation water application is timely.

You are providing that water to the crop at a time which is the most appropriate time so that that water can be stored into the soil. So in other words you will like to apply this water in the soil at that time when the deficit in the soil is maximum so that more water can be stored in the soil. And this application of water should be in right quantities. When we say right quantities what we mean is that if I have this is my soil profile which I want to store the water into.

We will look at these things in detail later. But this is the extent of the soil through which the root system of the crop draws the water from. And I know that to replenish this moisture of this soil with the moisture I need some quantity of water. If the supply of water is more it will

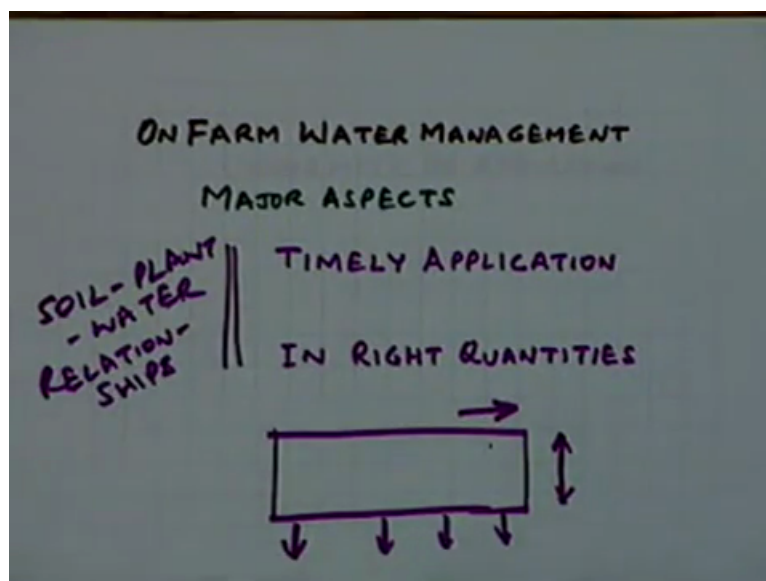
either run off the surface of the ground or it will infiltrate and it will go to the areas below this profile.

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So in both the cases there will be wastage of water. When we say in right quantities we must know how much quantity of water is required to bring this soil to a stage where it cannot hold more moisture. That is what is essential if you want to manage your resource properly. You must know when to irrigate? How much to irrigate? And the third aspect is uniformity of application. Now let me come back to this. If we look at these two aspects, these two aspects they are mainly dealing with the soil, plant and water relationship.

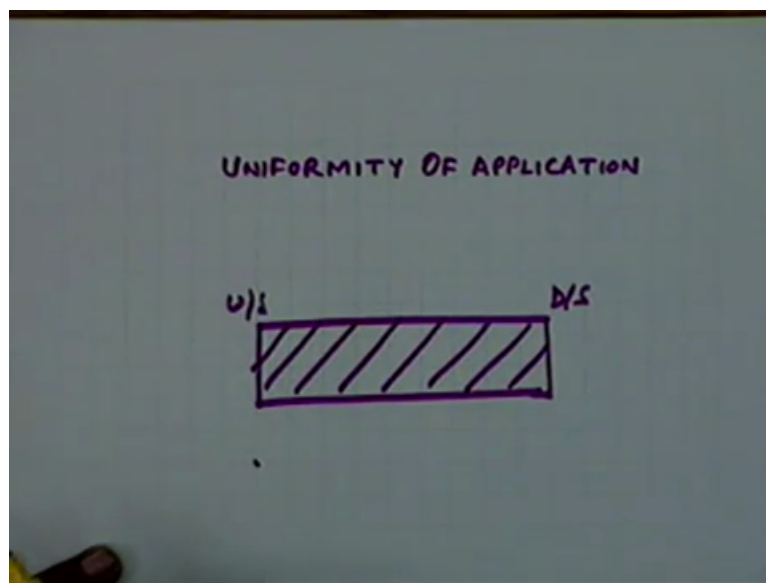
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So to have a better understanding of these two aspects we will try to learn more about the soil, water and plant relationships and as far as the uniformity of application is concerned what do we mean by this uniformity of application? We mean that if this is the field, this is the upstream end and the downstream end of the field, this is our soil profile which is needing the water so that the soil deficit can be removed.

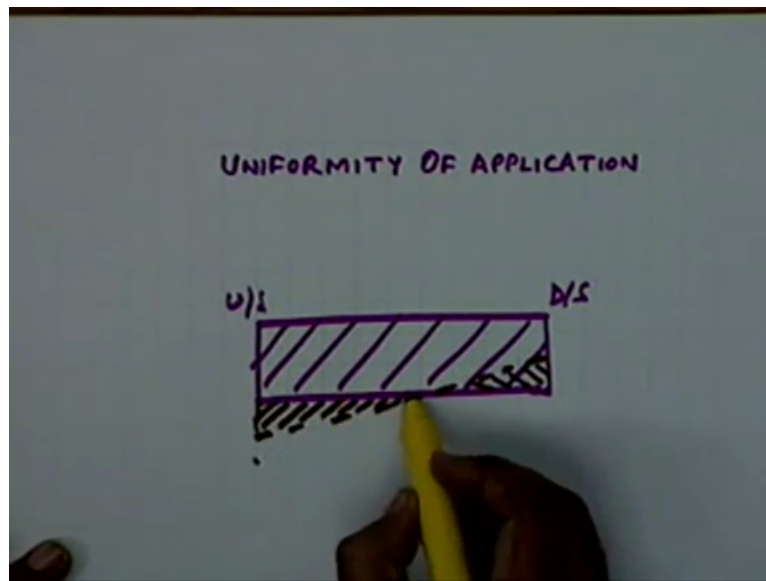
We want to ensure that the water which is supplied to this area is only supplied to this particular. The supply of water is not excessive enough so that the water populates to the lower areas or it goes over the surface.

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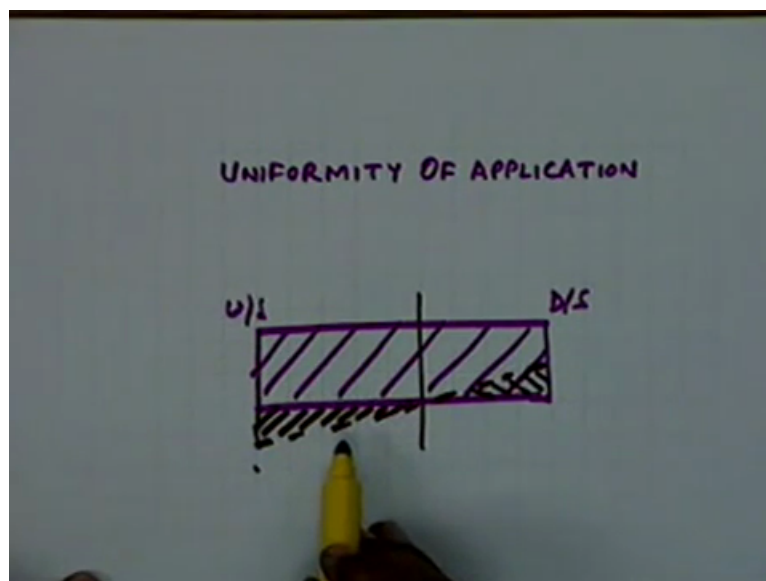
And even if there is some unevenness of the application it should not be affecting some parts of the field. If suppose I say that I have supplied the water in such a way that this is the final moisture availability. So if I look at this in this particular area I could not supply that much water as it was required whereas in this area I have wasted this much water, okay.

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But as far as the uniformity of the application is concerned it is not uniformly applied. It is having deficit conditions in this part of the field is less than the required quantity of water and in this part of the field water has been applied more than what was required.

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So this distribution is not uniform. This is the area which is a very important and this is dependent on the choice of methods of irrigation. So to understand more on this aspect of water management we will have to go deeper into the understanding of various irrigation application methods and look into the designs and ensure that a suitable method should be selected which is again a function of the soil type, the function of the steam size available, function of the slopes of the area.

There are so many other factors which will decide that which method is more suitable than the other one and that is another area which is very important to be looked into when you talk of on farm water management, okay. So that we will conclude the introduction to the irrigation water management by saying that the irrigation water management is very important if you want to manage your resources properly and thereby enhance the crop production of the country. Thank you.