Water Management
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Lecture 23
Border Irrigation System

Okay. Last time we were looking at the various design aspects of the border irrigation system and we had seen that in the case of borders where we want to use the end blocks, we had seen that we can make use of the surplus amount of water which is available as runoff by extending the length. It was one way or by reducing the intake or the stream size. We had gone through the various possible options available for extending the length and we had the relationships also, how we decide on the extension.

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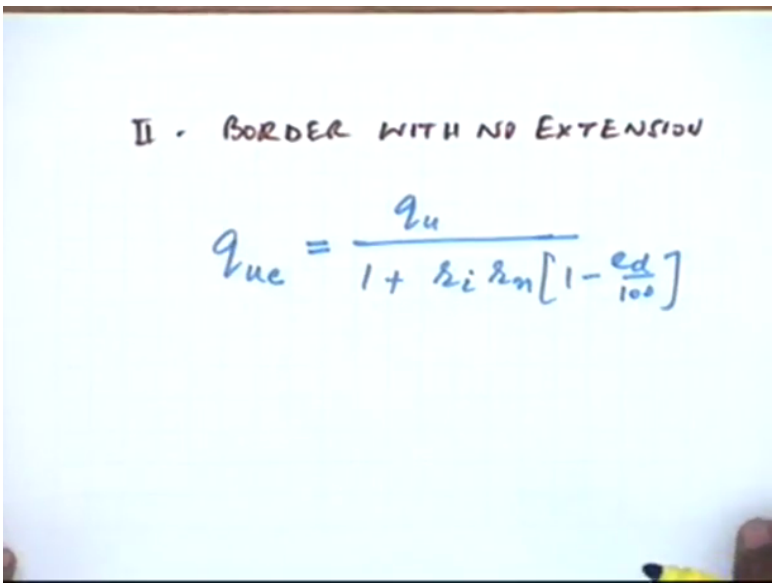

We had yet to see the other case where the case II where border cannot be extended. In some situations it might not be feasible for the farmer to extend the length of the border to accommodate that surplus runoff which is, which was available. So in that situation you can use the other option of reducing the stream size and accommodating that within the same border length, ensuring that there is no runoff.

When you have to do that, the relationship which is used to find out the unit size, unit stream size which is the changed unit stream size, the relationship involves ri, rn. And this is a relationship

where we had seen last time that ri and rn, ri is dependent on the intake family or the soil characteristics and the rn is the factor which is used to account for the effect of the roughness coefficient.

So there is relationship between rn and the n and rn, that is what we had seen in the last class. In this case only one assumption has been made. We are making assumption that the lag time, when you are changing the stream size the lag time will also be reduced. If you reduce the stream size, the lag time will be affected. So that lag time is not incorporated in this equation. We are making assumption that when you will reduce the stream size, due to the reduction in the stream size the lag time is not highly variable, is not appreciably changed, we are using the same lag time.

And with that assumption we are finding out what is the reduced stream size which you can use to account for the surplus runoff which was earlier available. And we are trying to accommodate that, we are trying say that. With this we have taken into consideration or we have looked at all the various design parameters which are required to design border irrigation system under both the situations where whether you are using the end blocks or in the previous case when you are not using the end block you can design your border strips.

This is only one aspect which is aspect of design. And even the design considerations, all these design principles or the design equations which you have made use of, they are derived from the evaluation of the borders.

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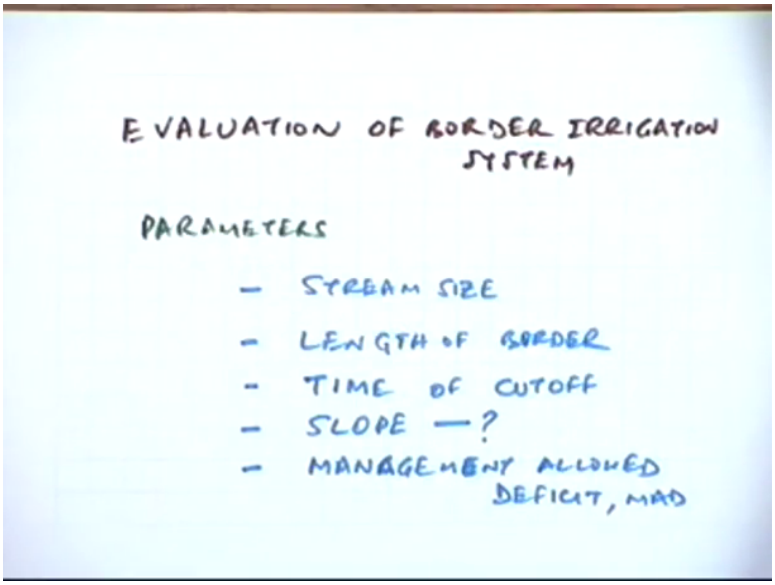

Now we will look at how we evaluate the border irrigation system. By evaluation what we are meaning is that we are trying to absorb these various parameters or various quantities in the field in situ. And having absorbed those things, we are trying to evaluate how good the system is working in that situation, are there any bottlenecks. This evaluation is very useful even if you have designed, suppose the one thing is that, one aspect is that while using the or while formulating those design criteria, you have used these actual experimentation to arrive at those things, to arrive at those procedures.

But even having done those things, having done the evaluation procedures, having perfected them, those procedures have been designed or those procedures have been formulated making use of some conditions which might be quite different. For example, suppose let us talk in terms of the playing of the grade, you have given some slope to the field. In the present case where you have designed the system, you have designed the length of the border, you have designed the stream size, you are certain how well, how good your the slope which is desired slope has been laid onto that field.

So all those design principles which you are implementing while arriving at those different quantities whether they are the dimensions or whether they are the stream sizes you are not knowing a priori that what will be the level of management which will be prevalent in your situation. So the evaluation in that situation will be important to find out are there any

bottlenecks in implementation of the design, are there any bottlenecks in the management which you are doing, are there any bottlenecks in terms of providing the stream size which you are, which you have arrived at.

All those problems you can sort out. This is, this can also be used as the problem solving or diagnostic to find out are there any situations under which the actual performance of your system is not as good or even closely related to what you have designed this system for. So the evaluation of any system, we are looking at the border irrigation system, for that matter evaluation of any system is a part and parcel of the actual situations of a system.

From, with these objectives whether is for looking at the procedures, the basic procedures which have been, which we have recommended for the design or whether is to find out what is the level of achievement in terms of the management or the operational aspects, evaluation is a must. So let us try to think of what are the various usual parameters which we like to, in the case of border irrigation system what are the various parameters which can be evaluated through this evaluation procedure or which you will be as a user you might be interested in.

These parameters can range, there is a range of these parameters. You might be interested in the stream size. You might be interested in that how the different stream sizes behave for in the field which you are irrigating as a farmer, how in that field, how the various stream sizes can behave in terms of maybe the advanced curve or in the form of recession curve. Thereby you can even check what are the designs, all those design quantities which we have arrived at, are they relevant to what you are obtaining in the field.

So stream size can be one aspect. Length of the border can be another aspect. But the length which you have arrived at how satisfactory results are being produced by those lengths. So you can check for some other lengths also. Then time of cutoff. This will be related to for how long you should supply water, when the supply should be cut off and how it is influencing the various other related parameters like the time of cutoff will also be deciding how much will be the lag time, for how much, for how long the water which is, which has accumulated over the surface how long it will take to recede or deplete.

What is the variation with the slope? This you might be in a position, unless you specifically prepare the fields with different slopes. So this is one factor which might not be that easy to

accomplish because in most of the cases when you go in for the evaluation you try to use the prevailing fields and those fields which we are using for your normal cultivation, the existing fields. So your experimentation might be one those slopes which are existing slopes.

You might not lay a separate field unless you are in a situation where you are doing this experimentation only from the point of view of revising your procedures, or your design methodologies which might be done in the situation of agricultural universities or some research labs. So this slope is sometime you might be interested in this variation but normally once the slopes are set you will try to retain those slope or if in the situation where you are laying new areas. In that case you can, the slope is also in your control and you might think of providing the slopes which are desirable slopes. So that time you might be interested in looking how the various quantities varies with the variation in slope.

Then you will also like to experiment with what happens when you irrigate at different levels of moisture content. So the management allowed deficit we had called it as MAD. Since the irrigation, when to irrigate is entirely dependent on a decision which can be made by the management whether it is the farmer or whether it is the irrigation department if it is dependent on the supplies. So how the irrigation, how these different parameters, how the advanced and recession curves they will vary when you decide to irrigate at different moisture content levels, that can also be evaluated. So these are some of the parameters which you might be interested in looking at or in looking at how these different quantities influence the, are influenced by the various factors prevailing in the actual area.

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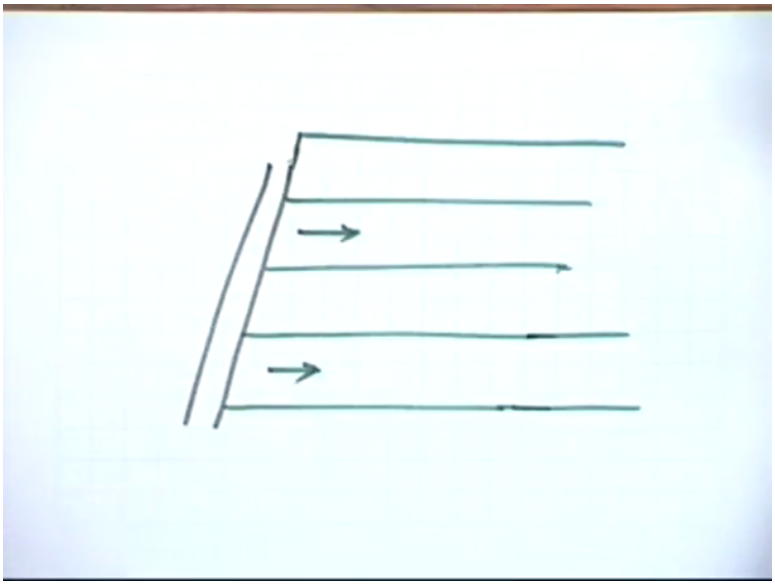

To achieve this you normally what you do is that you, for example, if this is your layout, you might be having these different strips. These are the borders. So you will have to, for the experimentation you will have to involve in some procedure which will look at what are the various things involved. But what your intention is that to do some experimentation on some of these strips. This can be one strip which is selected, another strip which is selected.

It is always better to take at least three strips if possible and is much better to have the strips which are adjoining strips. Sometime it becomes problem because most of the time when you are taking the observations, you will require to take the observations along the strip at different locations, at some stations which we have installed. We will come to that. So from that angle if you are having the water flowing in all the adjacent strips, it might become difficult to move into these areas. So in practice you take the strips which are alternate strips so that they are not slushy, there the water is not available in all the strips.

For experimentation purpose, you can indulge in that. And the lengths can be such that there is no restriction, you are taking more than the length which are actually to be used or which are the proper lengths. As far as the stream sizes are concerned, there also you try to vary the stream size and see the impact. So all those things are, they are part of the evaluation procedure. Let us try to look at these items one by one.

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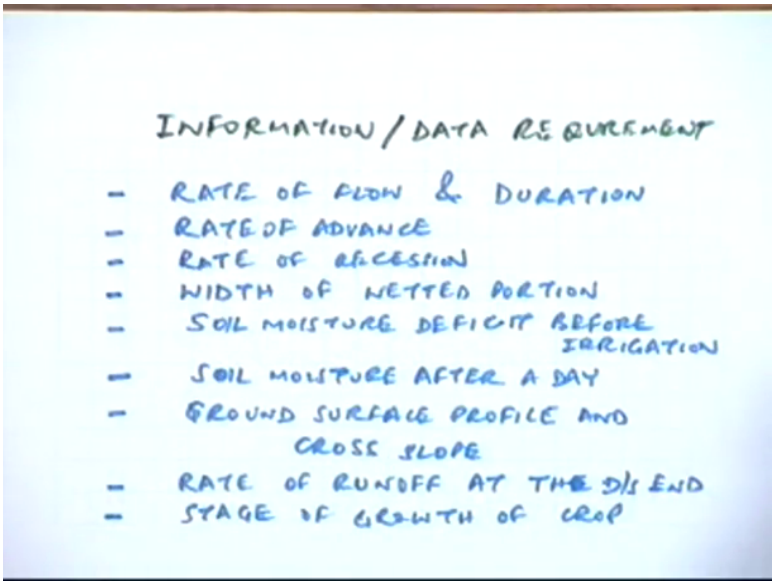

If you have to indulge in the evaluation procedure, first of all what is the information available which is required, information or data requirement. In most of these things you might be able to visualize because we have been discussing this for quite some time now. And we also know that what are the various items which we are interested in or the various quantities which we are interested in terms of the observations. Let us go through them quickly.

You will like to, for any analysis, any subsequent analysis you have to perform the type of data or the type of information which will be required. You will require the rate of flow or stream size and the duration also, for how long that stream size was made available on the head end of the field. You will also require to know the rate of advance. We have seen that rate of advance give you information which is desirable information which is giving information to find out how much is the infiltration or how much is the water which has infiltrated into the soil at that location.

So the rate of advance well be, you will be interested in, is the information which you will like to have. Similarly the rate of recession, how the water recedes past length of the field, that also is important because that is what will decide the time of opportunity. You will also like to know the width of wetted portion along the strip to find out whether the width is uniform or not, so that will also be required.

You will also require the soil moisture deficit before irrigation. That will give you the starting conditions that will be essential. You will also require the soil moisture after the irrigation. And when you say after, you do not take the soil moisture immediately after irrigation. You let the water which can drain out of the soil, drain out. And you normally take the soil moisture after a day, after the end of irrigation. So that will give you what is the final moisture which we have achieved the soil. We will also like to have the ground surface profile, it will give you what is the grade which is prevailing grade or the slope.

And any cross slope and the cross slope also. In some cases might be slight cross slope across the border length. That slope has to be, you must know because then you can take account of that, what will be the impact of that slope. You will require to know what is rate of runoff at the downstream end and there will be the surface runoff, runoff which is giving lot of the border strip that will be, that should also be known or it has to be recorded.

All these quantities which we are looking at we will have to make observations about those things. We are trying to look at what is the requirement in terms of various quantities which might be required for our analysis. You should also find out what is the stage of growth of crop because we had mentioned in previous portions. We have seen that how the stage of crop can influence the requirement as well as, requirement is one aspect because the requirement should decide how much deficit has been established in the soil.

Right now at this stage why we are looking at the stage of the crop? Because we can find out what is the appropriate n value which should be used, how the water will move. And the stage of crop and the type of crop, well we can say the stage of crop as well as the which crop is being used, that is what is going to decide the roughness coefficient prevailing at that particular time.

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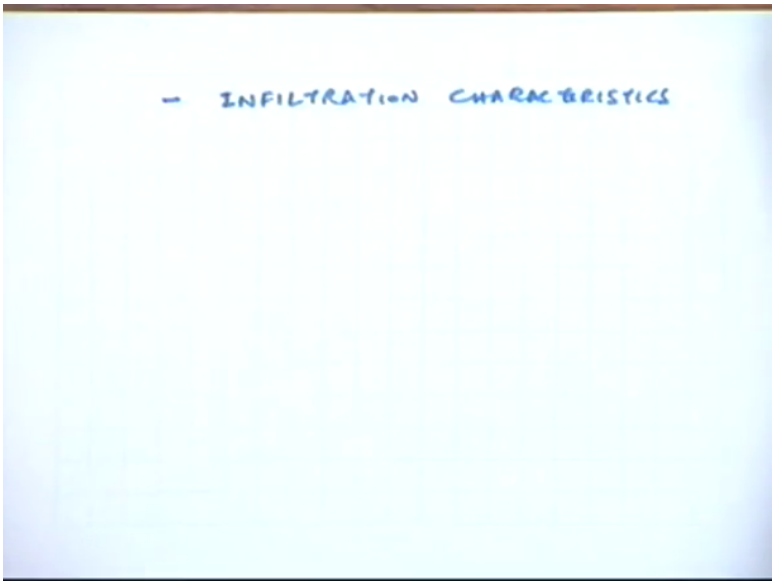

The other quantities which are the information or the data which will be required is about infiltration characteristics. What are the infiltration characteristics of a soil? That is very important if you want to use the relationships which are known relationships. You might like to, because the infiltration which is taking place is dependent on the soil type. And if you can evaluate the infiltration characteristics and you can use those characteristics in your formulations.

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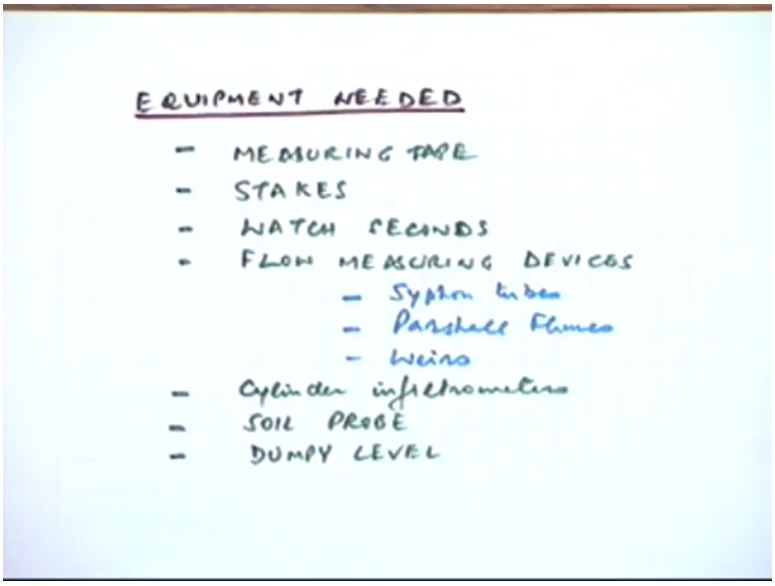

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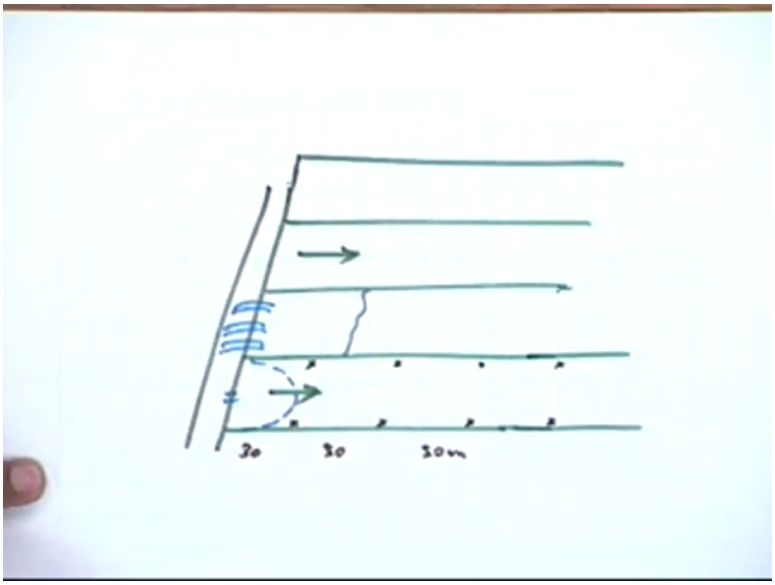

Then let us look at the equipment needs, what type of equipments will be requiring to go in for the evaluation? We will look at the major equipment. There will be some which will be needed. We might not be including them. You have to have some measuring tape because you will have to find out what is the width at different locations. In some cases if the ridges are not parallel to each other, you might, you can only check by using the measuring tape. So you should have some measuring tape, maybe 30 meter tape can be sufficient. You will require stakes. These stakes are required to mark the stations.

If this is the border strip, you will require some stations to be installed all along the length of the border, maybe on both the sides. And these pegs or the stakes have to be installed marking that these are the stations at which observations will be made. The spacing between these stakes can vary. You can have something between 10 meters to 30 meters depending on how accurate the data you want and how much labor you have at your disposal.

So it can be something like 30 meters, or 20 meters, 25 meters. Some approximate, some comfortable distance so that you can look at the variations, how the various variables vary along the length of the border. Then you have some, you have to have some mechanism by which you can keep track of the time, elapsed time. And for that some watch is required which has the availability of seconds, the second hand should be available, either is the stop watch or ordinary watch which has the seconds facility.

Then you, we will need the flow measuring devices. And the flow measuring devices which are common in the agricultural fields, you either use, we have earlier discussed that some cases you use the syphon tubes, especially in the case of border irrigation you use the syphon tub so that your waterfront is quite uniform since the width of the border is quite appreciable.

So if you supply the water from only one, if you take this, if you have only one opening, your waterfront might not be, it might not be uniform, it might be having waterfront which is something like this. And this portion the water will be moving faster and the sides water will not be moving at the same rate. So there will be some delay and your intention is to have the waterfront which is somewhat parallel to the this edge of the field. For that you can use the series of the syphon pipes which will ensure this type of waterfront. Okay.

You can also use Parshall flumes or weirs for finding out what is the stream size. This can be used either on the upstream end and for the surface runoff also you have to install something at the downstream end to find out how much is the wastage of water or water which is going out of the border. Then you will require equipment for the infiltration. And we have seen that the cylinder infiltrometer are used for that purpose.

So you can have one set or two set because you like to absorb the infiltration characteristics at some different locations of the field so that we can take the average. It might vary from one place to another place or it might, sometime you might make some error. If you want to take average value which is taking care of all these different possible errors, you will have to take observations at some reasonable number of points, maybe three or four points in the field.

You will require some equipment for taking the moisture contents and that can be in the form of soil probe. Or if you are using the laboratory method, you might need the auger and some soil sampler, some form of the sampler where you can take the sample and then go and test it in the laboratory by ovendrying it and finding out the moisture contents. Or you can have the moisture content by directly installing the probes in the field itself.

You will also require a dumpy level or some other level so that you can find out if you want to know what is the grade, what is the prevailing grade in the field. At these installed stations you can find out what is the elevation and then check whether the grade which is supposed to be there, whether it is there or not, or are there any locations where you have depression or elevated

area which will influence your different efficiencies a lot. This is in general the various types of equipment which will be needed.

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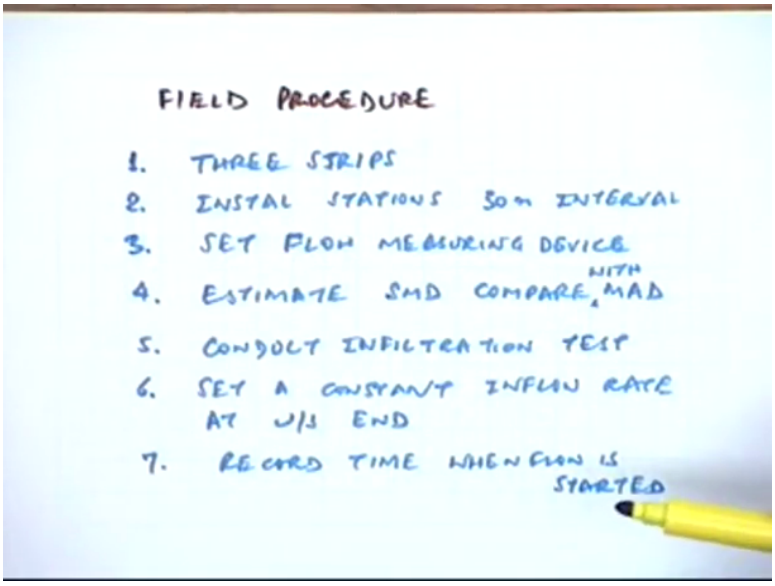

And next we will try to see what is the field procedure which has to be adopted so that you are taking all the observations which are desirable observations and nothing is missed in the process. The various steps, the various items in the same hierarchy we will try to identify. First will be that you will, you might not be interested in taking observations in the total field, is possible in some situation that you might take a segment of the field.

But if in case you have the possible labor available because in this process the way we have seen the and we will also look at the procedure, the field procedure, you will find that you will require quite a good amount of labor if you want to take all these observations at these number of stations which we have installed. So first decision will be that which segment of the field you will like to take. It should be a representative segment.

And having selected the representative segment, you will like to take at least three steps as we have discussed before so that you can have, you can vary the parameters in those three steps to certain extent and try to look at the impact of those variations. Then the next step is that you install stations at some interval, let us say 30 meters interval or maybe less if you can afford. These stations are installed at these regular intervals and then you measure the width also.

The next step will be to set the flow measuring device. In case is the syphon tubes and you will have to set the syphon tubes after selecting the number of syphon tubes because each syphon tube will have its own capacity. So since in all the three steps you are taking, you are using different stream sizes the number of syphon tubes will be accordingly set and you can install those tubes.

You can also install the flow measuring device at the downstream end which is required to find out how much will be the surplus or the surface runoff going out of the field. Having done this you will, you can estimate the soil moisture deficit by finding out how much is the moisture content. And you can compare with, compare the soil moisture deficit with the management allowed deficit because if your management allowed deficit is some level, some known level, let us say at 50 percent level of the available moisture content and if you are making this evaluation at a moisture content which is much different from that, then there will not be any comparison.

So you should be at least, you should ensure that you are closer to the management allowed deficit so that the relationships can be compared. Then conduct infiltration test at least three or four places in the, in each strip. Having done this, these are the initial settings or initial steps which we have to take care of before set the inflow rate. Having done that you set a constant inflow rate at upstream end. This inflow rate is set in one of the strip. This is the desired inflow rate.

You have a feeling that what is the, under the prevailing circumstances what is the inflow rate or if you have used the designs, that inflow rate which is the design inflow rate you have selected that rate, supply that in one of the strip and the other two strips, take one rate which is slightly lower than this and take another rate which is slightly higher than this so that you are covering a range. You are covering a range which is closer to your design inflow rate or the design stream size. Record the time when flow is started. This time is very important to be noted. What is the time when the flow starts into the strip?

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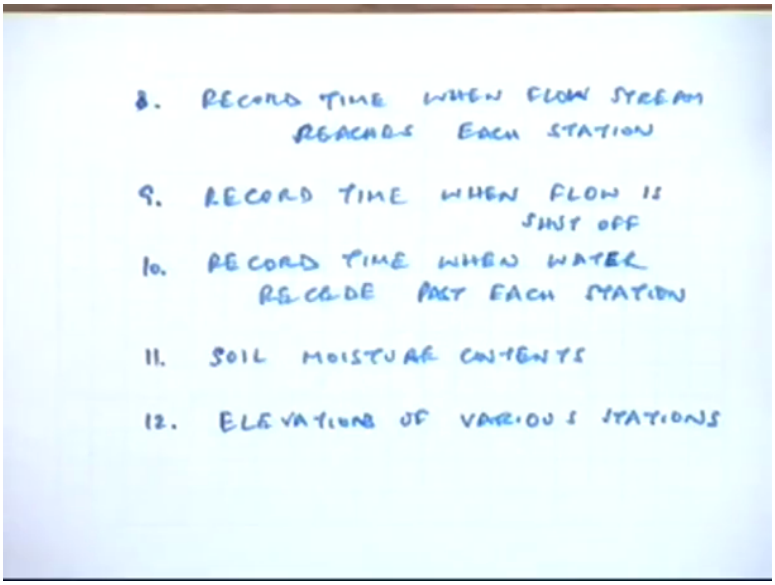

Then you will also have to record the time when the flow stream or the waterfront different, the same thing reaches each station, those stations which we have installed. When the water reaches at each of those stations, that observation has to be made, that time has to be noted down. Basically what happens is that there are performers available which are standard performer which can be filled when you are evaluating border strip. You can keep on filling those values, those standard performer.

I will show you a sample performer in the next class. These performers reduce the discrepancy which can come, which can arise out of wrong noting or in some case if you are giving free hand to the individuals because there might be many people there who are helping you in making these records. There can be some discrepancy and it might, we found later on that you cannot make out what observation belongs where.

So this procedure is a long procedure, is a time taken procedure. It has to be done in a very systematic manner. This is also, why we record the time when the water reaches at each individual station? Because we want to find out what is the advanced curve. So the advanced curve will be drawn from this data which we are recording. Similarly to get the recession curve you will have to record the time when, before that you will have to record the time when the flow is shut off because you are also interested in how much is the lag time. When the flow is shut off,

that time is also very important. You must record that what is the time when you stop supplying the water from the upstream end.

Then you record the time when water recede past each station. This information will give you the recession curve. Okay. So the very first station when the water recedes past that station, the difference between the time when shut off and the time when the water passes the very first station that is the lag time. After that all these timings when the water reaches each of the successive stations, that will give you the recession curve.

In many situations if the slopes are not very steep, the slopes are flat, you will find that this is a very difficult situation. You might not be in a position, there might be the water is not there but still because of some local depressions you might find that the water, it appears that the water is there. So making these observations of the recession is much more difficult than the observations of the advanced.

In many situation the water is taking some time, there is some local depression and just standing there and you might feel that is standing because of the that storage which has built up. That is not exactly so. In those situation where the flat slopes are prevailing, the recession curve might be a problem to certain extent. But then with experience you will know that how this has to be recorded.

And then it can also be slightly later on when you will draw the data because all this data which you are recording it has to be drawn and then you can do the analysis properly. So at that time you will find that if there is error in one particular station, that can be rectified because of the drawing. When you draw it, you will see that if the other stations have been noted properly, there is a problem on particular station that can be taken into, that can be rectified and is not that bigger problem. But in general it is quite difficult especially in those cases when the flat slopes are prevailing.

Then lastly you will have to take the soil moisture contents after the irrigation is over and that is after interval of at least a day. And you can also use, find out the elevations of various stations. This will give you the prevailing grade. These are the various data which are to be recorded, which can be further utilized for the analysis purpose.

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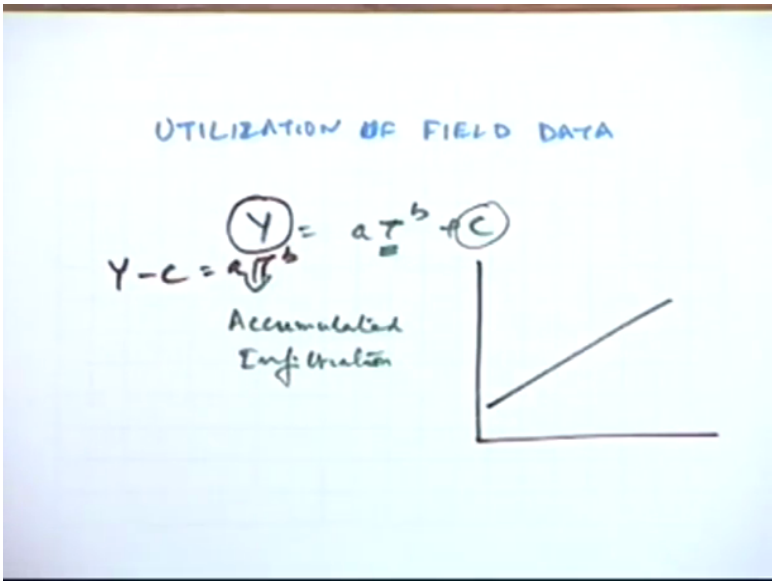

Let us have a look the field data which we have collected or it has to be made use of. I think what I will do is that I will take actual data, the actual field data which has been observed and we will make use of that and demonstrating that how the various things can be analyzed or various items which you are interested in, they can be derived using the data which has been collected. First of all, the data on the infiltration which you observed, that we had seen earlier that you are interested in deriving a relationship between the accumulative infiltration and the time.

So the relationship which we had used was of this nature where T is the elapsed time or the time for which the infiltration opportunity is there. And Y is the accumulative infiltration. So in practice what we do is that the observations which we have made we plot them on a log-log paper. And on log-log paper this should represent as a straight line, is not it? Provided in some cases you might find that there is slight change of slope, so in that case c can be evaluated in such a way.

You can have a relationship between Y minus c versus aT to the power b. So this will plot as a straight line. So the c can be evaluated and that can be incorporated. This is the very first job which we like to do because on, at any particular location we will find the opportunity time and that opportunity time will decide what will be the value of infiltration. So from that angle this relationship is very, very important because all your computations, all your subsequent computations are based on this relationship.

If you have incurred some error in, at this level, you might keep on aggravating the error in the remaining computations. And that is the reason precisely why we need to take this observation at many locations in the field. Okay. We will stop here today. Any questions?