Micro Irrigation Engineering
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Lecture - 40
Sprinkler Irrigation System

Hello participants. I am starting a new lecture on a sprinkler irrigation system. This is one of the important lecture under the pressurized irrigation category. We, in the previous lectures, discussed about micro irrigation emission devices. Those emission devices operate at low pressure, whereas, a sprinkler irrigation system requires a relatively large pressure and this is used for crops which are of higher height, maybe sugarcane, some plantation crops of very greater height water can be applied by using such system.

Now in this particular sprinkler irrigation system, we will discuss about its importance, its limitations. We will discuss about what are the different types of sprinkler irrigation system and its components.

So when we talk of what is sprinkler irrigation. Sprinkler irrigation belongs to the family of pressurized irrigation where water is being applied by using pressure and then water discharged through the nozzle in the form of a jet which breakdowns into the droplets, is shot into the air, and falls on the ground or the plant foliage. It follows a circular pattern around the sprinkler head.

Sprinklers have hammer device. If you look at this one here there is a hammering device it is there. And then it is a slow rotating or revolving mechanism. There is a hammer wedge or spring. This is the spring-loaded arm where the rocker weight which tries to balance the pressure which is coming due to water.

And so at the nozzle the water which is coming with the pressure, that pressure head is converted to the velocity head. And then such type of sprinkler systems these are

used for high-density plantation and this has another added advantage that it creates the microclimate near the vicinity of the plant.

These are the set of advantages. It has water-saving. It increases the yield. There are the system can be taken from one place to other places. It may be used for undulating land. It saves land as no bounds, ridges, furrows, etc., these are required. So whole area it can be brought under cultivation. It influences the microclimate because the water which comes it comes like rainfall.

So those water droplets it forms the water vapor. So mainly during the summer month, it creates a cooler environment, and particularly during a frost period sprinklers protect crops against the frost. It suits all types of topography except for the fine-textured soil. Suits to almost all types of crops. Ideal for germination of seeds and establishing seedlings.

There are some limitations that it is when it is being used in a ripened fruit. So the impact of the water rate may spoil the fruit. It can be not suitable for large trees. Because of the water which is coming to these trees they interfere with the operations. The jet gets interrupted. And then power requirement is relatively high and mainly particularly for the jet nozzle type of sprinklers.

Not suitable for heavy clay soil which has got low infiltration rate one has to adjust the application rate so that such type of soil, the plants or crop grown in such type of soil which are not the high, the very heavy clay or fine texture that can be used. Evaporation and wind drifts are very high when it is applied at a very low rate. High initial investment is involved. And water must be free from all the debris, sand, all dissolved salts because it may hamper the working.

Now there are different types of sprinkler irrigation system. Classification is made on the basis of the spray pattern. It could be on the basis of the rotating head kind of a thing. The other classification has been made based on the portability, based on the

movement. So these could be portable, semi-portable, semi-permanent, permanent, set move, solid set, or continuous move.

And these can be further on how the movement can be made. Whether it can be done by manually or it can be done by using the mechanically driven system or it can be a continuous moving system or central pivot system, it can be such type of system means your linear move, traveler move, or central pivot that is circle kind of a thing the moment is done.

You can see here the perforated pipes. The water is emitting out of the perforated pipes. So it means the perforated pipe system is one of the system it requires low pressure. Normally, such perforated pipes where the holes are made, it operates, at low pressure. The application rate for such type of pipe system is between 1.25 and 5 cm per hour. It has got some certain limitations that it requires low pressure means it is working at low pressure. When the pressure is high this particular type of system may not work. Release more water per unit area, this is one disadvantage of the system. And then it is unsuitable for soils which are of very low infiltration capacity.

A rotating head system, you can see here this is a device which has got a single nozzle. And then when the water it comes so there is a sprinkler head. So in this type of system, small spring size nozzles are placed on the riser pipe. So this particular unit is connected with the riser pipe. And then the common device to rotate the sprinkler nozzle is a hammer.

So here when it strikes, it strikes the jet emerging out of this. So there is this particular swing arm or jet that will hit on this arm. So what will happen, it will deflect and then again because of the weight here, so it will bring it back. So there is a small hammer activated by the thrust of water striking against when connected to it.

It could be two nozzles. Of course this particular device here right now you have seen it is a single nozzle. There could be two nozzles. One is the ring nozzle. Another one is the spreader nozzle. And then the sprinkler head is mounted on the riser which is

above the crop height and rotated through 90 to 360 degree to irrigate a rectangular strip.

The pressure requirement is 2 to 4 kg per square centimeter and it has got a different application rate. And these application rates are decided on the basis of a particular type of soil and also on the slope of the land.

Now coming to the classification based on the portability point of view, the system can be portable as name it is given portable. So all the components mean distribution component, the mainline, sub-mainline, laterals, and then entire pumping unit this is portable.

Then semi-portable. In the case of semi-portable, the source of water and pumping plant is fixed and the rest of the components are movable. So you can see here this is the main pipeline. There is a stationary power source of water where the pump is fixed. And then these laterals are moving from one place to other places. So all the entire unit is portable.

Permanent as the name says this is a permanent system means main lines, sub mainline, lateral, and with stationary pumping plant and water source. All the components of this type of system are permanently installed. And then it is installed mainly for such crops which are perennial in nature or for the entire season this is made.

Semi-permanent it has a portable lateral line, permanent mainline, sub-mains, and stationary water source with the pumping unit.

Set-move system or portable irrigation system. Set-move system as the name says, the movable from one set of irrigations. Once the particular irrigation it is done then it is taken place to the other place, another set place it will go. It can be done manually or by using a mechanical way or by using a tractor.

So this could be set-move remain stationary when water is when this, particularly when the irrigation is being given. So for a given time of irrigation, it will remain constant over there. Then it can be moved from one position to other position. And then there is a single mainline through the center of the field and one or more lateral on each side of the main these are attached. This set-move system can be hand-move or it can be tow-move or it can be side-roll or gun-type. So there could be different types of movement it can be made.

So another kind of system which you see here is a solid set system. So as the name says that is a solid set. This type of system has got enough laterals which can be operated at one time simultaneously, particularly when say frost control when it occurs or snowfall it occurs to protect the crop due to injury due to snow particularly in apple irrigation.

So all the plants will need irrigation at the same time, then, in that case, such type of irrigation system is very much required. So this is the solid set system. It is installed for the entire crop season or it can be permanently installed. So particularly this is beneficial to crops which need frequent irrigation in small depth. Such systems can be coupled with automation as and when depending on the requirement, depending on the temperature all that thing it can be automated.

Continuous move system. Here what you see, this is the center pivot system. It has got laterals and the sprinkler remains connected to the main and it moves continuously as the water is being sprayed. So this could be the center pivot system, traveler system, or linear move system. So a continuous move system can be of three types.

So here what you see this is a center pivot system. You can see here how circular irrigation is being given. Only the problem with the center pivot system if the field is rectangular in shape, then the corners are not irrigated. So the center pivot system consists of a pipeline rotating around the pivot and supported by self-propelled towers at a height of 2 to 4 m and 25 to 75 meter is the spacing between them. The radial lines rotate slowly around the center pivot by water pressure. Electric motor or oil

hydraulic motors. This means there could be different ways of movement. The towers are supported by wheels or skids.

A part of the circle sprinkler end gun is provided at the end here because in order to spread the water to this end so that the corners can be easily irrigated. Each point covers the large circular land area in the order of 60 to 100 hectare field at in one stretch it can be irrigated. And such systems are fully automated for large farming plants.

In India, we have the center pivot system in National Seeds Corporation and State Seeds Corporation where such farms are very large. As an individual holding such type of system it needs when the area is large.

Then there is the linear move system, this also falls under the continuous move system. So it is developed against the problem associated with the center pivot system. It covers the corners and reduces runoff. So this is the arrangement where you can see here how the linear moment the laterals are moving from one place to other place. And the average application rate is half of that of the end of the pivot.

It has towers with an electric motor and an alignment system. The lateral moves continuously in a linear fashion as the name says that is a linear move. So the water is supplied to the lateral through a flexible hose hooked to the mainline by traveling pumping plant. And that pumps water from an open ditch or it could be the other source of water. This can be powered by a diesel engine or electric motor if the electric supply is available.

Then traveler sprinkler system. This is the other kind. This is the source of water. There is a pumping plant. This is mainline and you can see here how the cable and hose is connected and then how the systems are operating. So high capacity gun type of sprinklers are mounted on the cart and hose that conveyed the water from a buried portable mainline to the sprinkler line.

The cart is pulled across the field by cable and supply hose. It is adaptable to many field sizes, shapes, and terrains. It can irrigate in a rectangular strip up to 900 m strip, wide strip. It can be transported from field to field at a very high speed but it requires the crop free from the tow path. These can be further you know hard hose, then the soft hose. This could be the hose can be soft or this one.

Then set-move system. It can be manually that is hand-move. It can be tow-move. It can be a side-roll. It can be gun-type. So such systems these are hand-move system, these are manually moved and where coupling, as well as the removal, means detaching it can be done manually.

Such types of systems are made up of high-density polyethylene pipe and then these are of the size of 50 to 100 mm in diameter, available in 6 m, 9 m long pipelines.

Tow-move system. Each lateral section has skids and wheels to pull the entire lateral to the next set position. You can see here these are the wheels where the entire system is brought from one position to the next position. A tractor hooked to the main end attached with the lateral to drag laterals in other directions across the mainline in an opposite S-shaped curve. Easier to move when main lines are buried.

This is not used extensively as the moving lateral may damage the crops. So basically those crops which are of the low-value crop means not very expensive, this system is used. So mainly for the forage or the row crops, it is being used. This is another kind of system that is a side-roll or wheel-move system. And the lateral you can see lateral is kept inside and on the top, this is connected with the wheel. So it is a mechanically moved system. It is taken from one place to another place mechanically and each section of the pipe in a side-roll lateral has the wheel. And the pipe serving as the axle of the wheel.

A diesel-operated engine or transmission with the reverse gear supplies the power needed to roll the lateral of length up to 800 m from one set of positions to the next. The lateral is commonly 12.2 m long having a diameter of 100 to 125 mm with a

wheel at its center and the sprinkler is mounted on the short riser on each end. This is what you see here, how the sprinkler is mounted on this one and it is in action.

A drain valve is located opposite to each riser and opens automatically during the pressure loss. It allows the lateral to drain and move quickly. So this is the arrangement here we have. Then there is a gun-type of set-move system. It consists of a large volume gun sprinkler mounted on a wheeled cart and trailer that is moved from one set to the set with the tractor or by hand. Sprinkler capacity these are of very high capacity about 4700 liter per minute. It has got a wetting diameter of about 180 m.

And it requires operating pressure from 480 to 896. You can see these are the guns. May be used for a variety of climates. And useful for large agricultural fields, lawns playgrounds, and turfs. It requires low maintenance, easy to install. The only thing that such type of sprinklers it does not have the good uniformity of water distribution.

But when we need to operate at one point of the field, so the loss of the crop as well as the movement is not restricted. Such systems are useful. The only thing that we should have is the portable water supply system means the water supply should be in large capacity and it should be available in adequate quantity.

This is sprinkler irrigation with mobile raingun which is another kind of a thing. This has been, this is another important device which is being used where this is the direction of travel and we can see that how the system can be rated. So this is a mobile raingun. Now this is important and some places it is being used and it is being available marketed in India also.

Now we learned in the previous part about the different components of micro sprinkler irrigation system. Now let us come to the sprinkler irrigation system components. So a typical sprinkler component, it is taking water from a source. This source of water can be a well, it can be a pond, it can be a reservoir, it can be a

flowing stream and then there is a pump. Now this pump here what you see that it is a coupled with the electric motor.

So this can be again operated by some prime mower. So maybe gasoline or it can be operated this pump can be operated with the diesel engine. And this is the suction end of the pump. And this is the delivery end of the pump. So the suction end of the pump it is provided with a coupling and then it comes to the check valve.

So check valve basically it is checking the flow or supplying the flow as per the desired quantity. Further, it is controlled by a gate valve. And then there is a larger when we want to extend the line. So there is a coupling where we can enlarge. So from the delivery end of the pipeline of the pump, the pipeline is extended, and then it is coming to another component which we can see there is a telescopic union.

So this is the main pipeline. And then this main pipeline when we want to divert water to this direction so there is a T connection. So this T is further connected with a lateral pipeline. This is a sprinkler lateral. And on this sprinkler lateral the riser pipeline is attached. And this riser pipeline has got a sprinkler head. So these sprinkler heads are provided at an appropriate location depending on the requirement.

Then in order to terminate the lateral flow into the lateral, there is an end plug has been provided. And then the water when we want to apply water to the set of laterals just now when I was telling you about the solid set system, so there you will have such type of laterals which are permanently fixed. And then there will be a set of laterals. So this is one lateral, this is another lateral.

Like this, there can be several laterals. And then in this lateral again there is the one connection which is the elbow. So with the elbow, using the elbow, water can be this particular lateral can be connected with another sprinkler head is mounted and by using the coupler with the riser pipe and a sprinkler. So this is and then at the end of the pipeline, lateral pipeline, there is an end plug.

And then water it goes in the line and it can be made in both sides. So there could be both the side the water can be supplied. So means the line can be terminated depending on the requirement or it can be diverted in one direction or water can be diverted in other directions, both the directions. This will depend upon the requirement.

So components of sprinkler irrigation system consist of a pump which gives adequate pressure. It consists of the network of the pipeline. Those pipelines can be the main pipeline, sub-main pipeline depending upon the requirement when the size is very large it can have, and then there are sprinklers, couplers valves, risers, bends, end plugs. These are the devices that are used in a typical sprinkler system.

So as I told you there is a pump. So the pump, the purpose of the pump is to provide enough pressure in the system and are taking water from the source. Maybe groundwater from the well. So pump create the force means through pump force is created through the sprinkler and then the water goes to the perforations in the nozzles if it is a perforated pipeline or it is coming to the sprinkler.

A high-speed centrifugal pump or turbine pump can be used depending on the requirement, depending on the place where the how the water is taken. If the water is taken from less than 8 m suction head then the centrifugal pump is used or submersible pump when the depth of water is greater than 8 m. So these are some of the guidelines.

In fact, the pump position can be when I was taking class, you can see that how the position of the pump can be shifted when the deep water is there, submersible pump or centrifugal pump that already I have explained you. So these pumps can be driven by using an electric motor or internal combustion engine, IC engines.

Pipe networks as I told you that these are the main or sub-main pipeline and the main or sub-main pipeline supplies water to the lateral. These are normally made up of

PVC or HDPE lateral supplies water to the sprinklers. They can be laid below or above ground level. Then on these laterals, risers are mounted.

These risers are of smaller diameter pipeline and then the height of the riser pipe is normally 1 m, less than 90 cm to 1 m. But when there is the plant height or crop height is more, say in the case of the sugarcane crop, the height of the riser pipe can be made. However to get the support a tripod is needed for each individual riser pipe to support this one so that it does not fall.

So a portable sprinklers could be aluminum, PVC. Now aluminum pipeline is not used, it could be made up with the PVC. These pipelines are made up of PVC or HDPE.

A sprinkler can be a fixed type or rotating head sprinkler. Fixed head sprinklers mean it forms a spray type of sprinkler. It depends on the smooth and grooved cones deflector kind of a thing that where when it is used mainly it is used for increasing the humidity. This requires relatively lesser pressure. Whereas rotating sprinklers it requires more pressure.

And the rotating head sprinkler could be of impact type, gear-driven type, or reaction type. So they have one or more nozzles. Means one nozzle is a range nozzle which is and another one in the spreader nozzle. Spreader nozzle, the water spreads near the riser pipeline, and then as well as the range nozzle, it spread the water at the distance part. These jets are rotated in a start and stop strike the impact and then bounce out one of the jets. The spring returns on to strike the jet again repeatedly. This is the action it does in case of your rotating head impact type of sprinkler.

The constant diameter nozzles mean these are the diameters are normally it is of the same size and it is made in such a way that it delivers the constant discharge. Diffuse jet nozzles, this is mainly for creating the humidity in a particular place mainly in the smaller these are of smaller size. In the greenhouses, such types of sprinklers are used.

Impact sprinkler, this is what you see here that it is a twin nozzle. So this nozzle is the range nozzle and this is a spreader nozzle. And the jet coming out of this, this strikes here and then this spring it brings it back. So once it strikes this particular arm deflects and then supplies the water. Normally, the angle of throw from this one, this is the trajectory this is 32 degree and this is a bearing, on this bearing, the sprinkler rotates about its axis.

You can see these are the different components. This is an oscillating arm shaft and this is the oscillating arm which oscillates when the jet ejects out of this one. So it brings back. So already I have explained you, so this goes. Then a gear-driven type of sprinklers are there. It is driven by a small water turbine located at the base of the sprinkler. Series of gears are used to reduce the speed of the turbine. It may have one or more jet that rotates around the vertical axis of the sprinkler. Unlike the impact type of sprinkler, gear-driven sprinklers rotate smoothly without any splash.

There are reaction type of sprinklers rotated by torque produced by the reaction of water leaving the sprinkler jet. This is the thing which is making in the majority of the impact type of sprinklers also. When the jet leaves the water, it creates torque. That is causing the movement of water and it operates at low pressure between 70 to 210 kPa.

Now other components of the sprinkler systems are they are you know very important component and these are as important as the sprinkler system because these are needed? So couplers for coupling the pipeline, water meter to monitor the flow. Flanges and couplings. They are required for proper connection to the pump and suction and delivery end. Pressure gauge. It is another important component to monitor the pressure how at what pressure the pump is operating. At what pressure water is being flowing in the main pipeline, sub-main pipeline. And also to monitor the flow from the how much at what pressure sprinkler is ejecting the discharge.

Bends, tees, reducer, elbows, hydrants, butterfly valves, and plugs. These are all important components. So you can see here this is the quick release coupling QRC which is made up of high-density polyethylene. So these are the QRC. This is the end

plug. All this is made up of HDPE or PVC. Of course, this is the end plug and then there is a rubber gasket at the end. So water does not come out of this. This is a tee. When we want to divert water at 90 degree, or it is a bend. So such type of devices are required when we want to connect the pipeline with one.

This is the threaded pipeline, of course, steel pipeline pipe. Sometimes it is needed. Of course, now slowly all these couplings which were made up of GI pipeline or steel pipeline this has been replaced with the PVC. The only thing that is where the riser pipe is to be so this is made up of brass or gunmetal at this place.

And then on this place, you can see here this is the one part and then sprinkler riser pipe is attached this one. This is the quick coupling aluminum pipeline. These were being used earlier. Now aluminum pipeline has been fully replaced with PVC or HDPE. This is the rigid PVC.

So this particular topic you can go in detail, refer these books by James, by Professor Michael, quite a good information is available. You can also have internet references.

So in this particular lecture, we discussed about the different types of the sprinkler system which is based on the portability or moving system. We discussed about the components and what are the different components which are there.

In the forthcoming lecture, we will discuss about what are the design considerations and then what is the system hydraulics. So thank you very much for patience in hearing.