Micro Irrigation Engineering

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Lecture-01
Micro Irrigation-Introduction and Scope

Hello participants, I am introducing a new subject on micro irrigation engineering. This subject has been designed considering the importance of water and then the amount of water which is used for irrigation. Irrigation consumes a huge amount of water and there is a lot of wastage of this water. There is a demand by other sectors, industries, domestic purposes, and there is another utilization of water resources.

So, irrigation is an important component. Ours is an agriculture-based economy. So how to reduce the water supply for agricultural production, micro-irrigation assumes an important role. We have introduced this particular subject on micro-irrigation engineering on the NPTEL platform and this is lecture 1. In this lecture, we will be discussing what is the importance of micro-irrigation? and what is the scope of micro-irrigation engineering subject.

In this particular lecture, we will be discussing a brief introduction of the course, the concept of micro-irrigation, and what are the scopes of micro-irrigation.

So, this course is of 12 weeks duration. In these 12 weeks, we will cover 60 lectures for the entire subject and each lecture will be of 30 minutes duration. Each week there will be about 2.5 hours and at the end of each week, there will be one assignment. So, a total of 12 assignments will be there for the whole course. At the end of the course, there will be an online examination.

We will be covering mainly broad topics related to soil, plant, water, and atmosphere relationship. How to determine the water requirement of the crops and then this can be supplemented by using the appropriate micro irrigation devices. Measurement of irrigation water

is another important topic. Drip irrigation, micro-sprinkler irrigation, fertigation, automation of micro-irrigation, are broad topics.

Now, the total course contains 11 modules and each module has lectures. Also, we have design tutorials on major topics. So, module 1, deals with the fundamentals of fluid mechanics and soil water. Micro-irrigation and its introduction will be covered in lecture 1. Fundamentals of fluid mechanics and its application to micro-irrigation will be covered in lecture 2 and followed by soil water concept, soil water constants, and infiltration in Lectures 3 and 4.

So, on these topics whatever the fundamental concept will be covering, there will be some numerical problems which we will work out in tutorial 1. In lecture 2, you can see here we have given the fundamentals of fluid mechanics and its application. So, we will not be giving the wide coverage but its importance. We will be refreshing your knowledge of what you have been studied in a major fluid mechanics course. But it's basic fundamental, its units, and then mainly the terminologies which are there in the fluid mechanics that will be utilized in micro-irrigation system is covered in this lecture 2.

Module 2 is on crop water requirements. In this particular module, the basic parameters are used to determine the evapotranspiration and there are various other terminologies which are in evapotranspiration that will be covered in lecture 6. Followed by lecture 7 crop coefficient and crop water requirement is another topic that will be dealt with in lecture 8.

Demonstration of agro metrological instruments. We have established several equipments, mainly you can see here lecture 9 and lecture 10 demonstration part. So, demonstration of established equipment in our farm. These types of equipment and these data we are using for various purposes. So, we will discuss this in lecture 9 and lecture 10. Then whatever the basic concept which we have covered, we will be solving numerical problems on crop water requirement in lecture 11.

Module 3 is on irrigation water management, which will be covered in week 3. So in irrigation water management, lecture 12 is meant for irrigation scheduling. We will be discussing that how much amount of water is to be given at what intervals based on the evapotranspiration requirement which we have established. So, soil-water-plant monitoring instruments, this is another important component which you will know.

And this is a very important part one should learn about irrigation scheduling and irrigation water measurement, the important topic which will be discussed in lecture 14. Then irrigation efficiency, any system when we are installing how efficiently it is working. So, whether it is a surface irrigation method, whether it is a drip irrigation method, whether it is a micro-irrigation method, all these methods different terminologies are involved.

How to evaluate the system? So, that will be covered in the topic of irrigation efficiency in lecture 15. Lectures 16 is kept for tutorial 3 which will be solving the numerical problems on irrigation water management.

In the 4th week, we will be covering the module 4 lectures, and module 4 is kept for irrigation water lifts and pumps. So, irrigation water lifts mean the available water, whether it is at a shallow depth or it is at the deep water table. So, different types of devices which are used for lecture 17 and 18, it is meant for irrigation water lifts and pumps.

The next part is irrigation water quality. Irrigation water quality for the drip irrigation system. It is important because of the devices which are used use very small orifices. So, water when it is passing if it is of poor quality, is likely to be clogged. So, irrigation water quality is another important component of this particular lecture.

And then tutorial 4 is kept in lecture 20, that those are the problems which are related to the water measurement and pumps will be dealt with in tutorial 4. Lecture 21, here are all the different methods of water applications. We discussed in module 3 irrigation scheduling, in

module 2 we discussed evapotranspiration. There we discussed how much amount of water to be given at what interval should be given?

Here is how to give irrigation water, for irrigation method whether it is a surface irrigation method, it is subsurface irrigation method or it is the irrigation given by sprinkler or micro-irrigation. So, here the broad classification of different methods will be discussed in lecture 21.

We are discussing the main course, which means up to module 4, we can say we have discussed fundamentals of the subject, basic terminologies which are used. And now, those terminologies and fundamentals will be utilized in the micro-irrigation component which will start from module 5. So, you can see here lecture 22 to lecture you can say here lecture 30 means, 5^{th} week and the 6^{th} week, all these topics are related to micro-irrigation.

So, in micro-irrigation, the topic says lecture 22 you have drip irrigation, different types of drip irrigation, and then drip irrigation design consideration and system layout, types, and selection of emission devices, hydraulics of drip irrigation pipe network. So, we studied fluid mechanics, now the fundamentals of fluid mechanics will be used for the design of the drip irrigation system pipe network.

Numerical problems on design of drip irrigation system, fertigation application, methods of fertigation, and then different types of filters, which will be covered in lecture 30. And then the numerical problems related to the selection of emission devices as well as the fertigation will be dealt with in tutorial 6, this is given in lecture 31.

Then, this module 5 continues which we see week 7 and week 8 are also on micro-irrigation different topics. So, installation and operation of drip irrigation system lecture 32, maintenance of drip irrigation system. You will see how the system can be installed and then this is a beautiful example because the students and participants will be exposed to how to install the system.

This is an important topic when any student joins in the micro irrigation industry, they are given a task to go to the field and install the micro-irrigation system. How to maintain the micro ignition system? So, this is a very important topic. Demonstration of drip irrigation components and evolution of drip emitter. This is practically a system that we have developed for how to evaluate the performance of drip emitters.

So, we have developed a test bench and then you will be given enough time to understand that how to evaluate a drip emitter. So, this is another topic, which is important. Then, soil water movement under drip emitter, means the research work has been carried out by the large number of students who worked with me and this is basic fundamental research means work which is required one should know when we know the infiltration process. But when the water coming from a drip emitter, when it is falling on the soil, and how does it move below the soil surface.

So, here it involves research exposure and how the water is moving under a drip emitter. Then design and development of a drip emitter, an economical drip emitter, is another challenging task and we will be given exposure to how to design. Then fundamentals of the continuity equation, fundamentals of Navier-Stokes equations. They will be utilized for the development of dripper, we did this work at our place by some of my students they have been working and we are exposing you to this topic so that you can come out with another different low-cost drip emitters. So, those things will be used here.

This is not only for the agriculture engineering student rather this is also useful for the micro-irrigation industry. So, that they can design, they can come out with the economical small size dripper. So that it becomes less expensive and farmers can adopt such types of drippers. So, lectures 37, 38, and 39 will be dealt with in week 8 of module 5 and these topics are already given in these lectures.

Module 6 is for the sprinkler irrigation system. This sprinkler irrigation system is an overhead sprinkler irrigation system. This is also an efficient method of water application. This particular method of irrigation initially was used for tea gardens but now a large number of farmers are showing interest. So, it's basic performance how the sprinkler system looks like, how it should be designed? So, lectures 40 and 41 will be covered in week 8.

Week 9, we are talking about how to evaluate a sprinkler system. So, this is also a laboratory experiment you will be given one sprinkler head and then various parameters that are required to evaluate a sprinkler head that will be discussed in this lecture 42. There are numerical problems related to the various aspects of sprinkler irrigation systems and their design will be discussed in lectures 43 and 44. Then, its installation, layout, its operation, and maintenance will be dealt with in week 9 of lecture 45.

Module 7 is another important part. Any manufacturer, when they manufacture, it's quality and its reliability of working, it is very important. The Bureau of Indian standards and international research standard organization in Switzerland. And the Bureau of Indian Standards is located in New Delhi. So, the standard they have specified the quality parameters, and those standards will be discussed for the drip irrigation system in lecture 46. And then, the standard and quality assurance of sprinkler irrigation system components has been dealt with in lecture 47. So, module 7 is meant for standards and quality assurance of irrigation system components.

Module 8 is another important component. This is on a solar PV-operated micro-irrigation system and this will be covered in week 10. Lecture 48, is basically for the basic understanding of why solar PV, that is, the solar photovoltaic system for irrigation part 1 where different terminologies, different important terms it will be dealt with. Lecture 49, is about the design of the system and then how to match the solar power system with the micro-irrigation system. So, the matching and integration part will be dealt with in lecture 49 and then in lecture 50, we will be dealing with the numerical examples on solar PV irrigation systems.

Now the government of India is promoting this system and a large number of engineers not only from the agriculture engineering discipline, but the other disciplines also have engineers say electrical engineering, as well as electronics engineering, will be needed for this particular aspects and already this system is being installed for power generation. So, one should attend this course, this particular topic is very important from that point of view.

Module 9 is on automation of micro-irrigation system and this is a given in 11th week. And then, all 4 lectures on automation of micro-irrigation systems, that is lecture 51 is part 1 where we are discussing different types of the systems of automation, Internet of things (IoT) then your information and communication technology, there are various. And then, different types of sensors how to integrate these sensors with hardware, and then how to automate micro-irrigation system, these are discussed in lecture these 4 lectures. The point is this, these lectures are useful not only for the students those who are attending, but whether industry those who are interested to come with it, is useful for them and then the lectures are useful for agricultural engineering.

These lectures are also useful for electronics and electrical engineering students and we invite them to be there. So, that the discipline of this agricultural engineering and this particular course, micro-irrigation engineering this will be useful and then it can go to the field and farmers can adopt these technologies.

Module 10 is the economic evolution of the micro-irrigation system, any system when we are talking unless it is not economically viable, will not be accepted by the community. So, what are the different terminologies which are used for economic evolution, economic analysis will cover in lecture 55, lecture 56, and lecture 57? These all 3 lectures on the theory part of the economic analysis have been discussed. And then, the numerical examples related to the terminology, theory, which we are discussing in those three lectures will be used to solve the problems related to the economic analysis of the micro-irrigation system.

Module 10 is dealt with in week 12. So, in this one module 11, we are discussing precision agriculture. This is a new emerging topic and where a large number of disciplines are interested. It's not only agriculture engineering. Because it involves various facets; it involves the sensors, it involves the remote sensing application, it involves GIS application, and it involves mechanical engineering. Mechanical engineers are interested because it involves various aspects of robotics, it involves the various aspects of this UAV unmanned aerial platform that is the drone.

So, a large number of disciplines are involved and this is where micro-irrigation also played at one of the input components. So, we will be discussing in lecture 59 and lecture 60, it is the concluding part of this course, how this course what we have developed, what we are dealt in all 59 lectures will be covered in lecture 60, that is micro irrigation engineering epilogue.

Now, coming to this particular lecture in more detail let us try to know about the micro-irrigation system. You know water is a precious element. It is a nature's gift and without water no life. So, water is the life of any living system all of us will survive when water is there on the planet. So, living systems exist on the planet because of the availability of water. And for any country, the growth and development, economic development will depend on how efficiently water is being managed and it is available on the planet.

So, water demand is by various sector: agriculture, wildlife, domestic, industry, there are all other sectors it requires it has a demand. Health and environment also require water and the health and environment of any city, any country it depends on how efficiently water is being used and managed as well as available in the system.

Now, when we are talking just now I told water use and how it is being utilized and the loss or wastage it is taking place. So, we are taken for example you know 3 aspects, one is agriculture, another one is domestic, industry, and reservoirs. Now if you see means here from 1900 to 2025 the projected forecasted part and these are the available data. So, when we are seeing these data, 3 components have been discussed.

So, green here in case of agriculture when you are seeing here, the dark green it is for water withdrawal means water is extracted either from the groundwater or surface water that is the withdrawal it is being taken. So, you can see here mean the water withdrawal is continuously kept on increasing. There are no decrees rather it is increasing exponential increase is there. And then also the consumption means the water being withdrawal or it is being supplied.

So, what we see here is the consumption and then water withdrawal. So, the rest of the thing is the wastage, it is the loss, which means we are wasting more than what we are withdrawing. And this gap if you see this gap it keeps on increasing. So, this gap which we will see here that this gap keeps on increasing. So, this is the in agriculture as compared to if you see here in domestic supply, there is a demand it is increasing. It is also you see their water being distracted while the domestic sector is also increasing because of the increase in population.

So, demand is increasing, of course, the living standard of the people, people have started using washing machine, in washing machine also a lot of water. So, various aspects where the water is being consumed and water which is being used for a particular purpose, there is a huge amount of water it could be wasted. The same thing is happening in the case of industry and then a huge amount of water it is going as the lost as evaporation loss. So, in various sectors, the water which is being extracted and then it is being used there is exist.

And then global when we look at the global water scarcity. So, what we see the in 2000 these are already you know the availability of water is less than 1000 cubic meters per person per year; it is less than available in these places. But when we look at 2050, you know where the dark red exists means it is increasing and India is not safe. We will be also falling between 1000 to 2000 cubic meters per year per person that is the projection. So, demand for the water, it going to be more and we will be falling in the category where water is scarcity zone will come.

Now there are you can see here the from the Indian perspective point of view, we have the total if we take there are 2 important sources that are land and water. Flow out of the total global water scenario if you see we have got only 4% of the water scenario and 2.3% land. In 2.3% of the global area, we have got 17% of the population and 11% is the livestock.

So, means we have a huge population, less amount of water, less amount of the land and that is what it is being reflected in the number wise if you look, we have got out of the 1953 billion cubic meters of water, only 690 billion cubic meters of water is surface water available. Similarly, the groundwater for total utilizable water resources is 1032 billion cubic meters and so means the present level of utilization is about 60% of the available water. So, we are left only 40% of the water in the years to come.

This is another interesting part if you see here, to take 1 cup of coffee we need you to know 140 liters of water. Similarly for if we are cultivating rice crops to get 1 kg of rice we have to huge 3000 liters of water. So, these are some of the important statistics, we need to know from this particular slide if you look at these, we need to grow such crops which are less water consuming and also we need to go for such methods of irrigation where there is less water wastage.

So, if you look at the figure this is just to make you aware that we have a 329 million hectare area out of which 172 million hectare area is cultivable area. And the net irrigated area is about 70 million hectares and based on the different crops which are suitable which can be grown by using micro-irrigation system that is 69.5 million hectares from this 69.5 million hectare, 27 million hectare area it can be brought by using a drip irrigation system. A sprinkler irrigation system can be adopted in a 42.5 million hectare area.

So, by converting if we convert 1 lakh hectare area under a micro-irrigation system, we will be saving 347 million cubic meters of water annually. Just too simply by 1 lakh hectare area and we will be saving energy of 271 lakh kilowatt-hour per year. So, this is the another exchequer of

rupees 105 crore rupees will be saved if we are using a micro-irrigation system to apply fertilizer along with irrigation water. That is why MI plays an important role.

What is MI? What is micro-irrigation? Micro-irrigation is the precise application of water at the root zone of the crop either in the form of a drop by drop or continuous drop or tiny streams through you by using the emission devices. We deliver here the water to wet the plant root zones means wet the soil near the plant root zone. And it can be kept at the soil surface or below the soil surface.

We need to select an appropriate emission device considering the type of soil, considering the particular type of crop, and then knowing how much is the amount of water it requires?

It requires low-pressure systems and different devices are used it could be a drip emitter; it could be a micro-sprinkler, jet sprayer, bubbler, fogger.

All these are the devices that are used. We will be discussing in detail of course when we will come to that particular lecture. But this is the overall layout of the micro irrigation system where water is being supplied from the source, it goes to the nutrient tank, it goes to the filter then it comes to the main pipeline. And from the main pipeline, it is supplied to the sub-main pipeline depending on the number of the laterals, we want to give irrigation accordingly the water will is given to the laterals.

These are the smaller pipelines and on the lateral pipeline emission devices are fitted and then water is given to the individual plants. So, there are different ways of giving water to the plants that we will be discussing in coming lectures.

Why micro-irrigation system? Because you can see here when you compare the water utilization and then water application efficiency, when we give a flood irrigation system the application efficiency is 40 to 60%. When it comes to the sprinkler irrigation system, we are getting

application efficiency from 70 to 90%, because the center pivot system is also one of the types of sprinkler irrigation system. And when we are using micro-irrigation or drip irrigation systems we are achieving 90% of irrigation.

So, you can see here when we are using a surface conventional method of irrigation, how the water is being given? The whole freely flooded plant does not need that much water when we are using the drip irrigation system, you can see only the part of the area where the water should be given, it is being given. So, that is why the micro-irrigation system takes an important role and this would be taught in the program.

It has got some certain advantages there are water saving, the enhanced plant growth and it gives the higher yield, there is a uniform and better quality of the produce. Here, there is an efficient and economic use of fertilizer. I was telling you we are saving an exchequer of 105 crore rupees when we only irrigate with the micro irrigation system in a 1 lakh hectare area. That is why you know the economic use of the fertilizer, efficient way of the water fertilizer can be given.

There is less weed growth because water is given at a particular point, so the whole field is not flooded so moisture is not available. There is less weed growth take place, the possibility of using saline water. This method of irrigation can be used in the wasteland also because water is applied at a very slow rate. So, there is no soil erosion, there is flexibility in operation you can give water at half of the field at one time, the whole field at a straight, there are several operations it is possible because it has control.

Easy in installation, well this requires skill in installation. I will say once it is installed, so there is no problem at the later stage. There is a labor-saving, suitable to all types of terrain means level land, it is hilly terrain and down the slope all kinds of terrains it can be. And then because the part of the area it is being irrigated, it is not coming in contact the whole field is not flooded for there is less possibility of disease and pest infestation.

There are you know disadvantages and limitations of the system. It involves high initial investment; no doubt the government of India is promoting this irrigation system. So, a subsidy to the tune of 50% is given to the farmers. It involves of course maintenance requirements because emitters and clogging, emitters clogging is the problem, yes it is there and this needs regular, so this is one limitation.

Restricted plant root development, so this means when it is the water is being given from the surface, so root development takes at that is one of the limitations. Salt accumulation near the plant root system takes place, yes, if we are using salty water, saline water then this is kind of a thing. So, we need to apply at a higher discharge rate.

So, this particular lecture, these are the references you can refer to in this particular course.

And so in this particular course, we discussed the different modules and different lectures which are there. We also discussed the importance of a micro-irrigation system. In the forthcoming lecture we will be dealing with the fundamentals of fluid mechanics and its application to micro-irrigation systems, thank you very much.