Micro Irrigation Engineering
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Lecture - 09
Demonstration of Agro Meteorological Instruments

Dear participants, in this lecture we will learn various agro-metrological instruments. There are various parameters, which you learn in estimating evapotranspiration, in determining evapotranspiration by measurement. So, in the field, we will show you these parameters. How to monitor various climatic parameters, various weather parameters which are dealt with?

So, let us go to the field where we have installed these gadgets in an agrometeorological station. These gadgets the instruments have been installed and we will demonstrate you in the field itself.

In the agricultural and food engineering department, we have established an agro-metrological observatory. The agrometeorological observatory is of the size of 60 meters by 40 meters. Where various instruments are installed to monitor data on rainfall, maximum temperature, minimum temperature, wet bulb temperature, dry bulb temperature, evaporation. We are recording data on wind speed, we are recording data on which direction wind is blowing, we are recording data on solar intensity.

We are recording data on total sunshine hours and then there are various other data which are important for irrigation purposes, for hydrologic studies so all kinds of data.

Now, in previous classes which we have discussed estimation of evapotranspiration and where we emphasized the use of these climatological data for estimation of evapotranspiration, where you have seen that maximum temperature, minimum temperature, average temperature as well as solar intensity, total sunshine hours, relative humidity.

These data were used to estimate evapotranspiration. So, evapotranspiration studies or for any irrigation planning is studies such data are very important. And now we will be discussing each of these units in detail. This is a Stevenson's screen. Stevenson's screen is made up of wooden material. And in Stevenson's screen, what we see here are the battens and they are inclined battens.

So, that air can easily go inside the house. Now in the Stevenson's screen, we house a dry bulb temperature thermometer, where we record what is the air temperature? And then another one is a wet-bulb thermometer. So, wet-bulb thermometer, the water from this particular bottle is transferring to this muslin wet cloth. So, that the tip of the bulb of the thermometer is kept in this muslin with the wet cloth.

So that it monitors the wet-bulb temperature of the air. So, these two temperatures, dry bulb as well as wet-bulb temperature. This is used to determine the relative humidity of the air. Now, in this particular device monitoring minimum temperature and maximum temperature these two thermometers are also housed. Now, we can see right now, the minimum temperature as of yesterday when it was recorded is 19 degrees Celsius.

Whereas, the maximum temperature in last 24 hours means in last these 24 hours it was 33 degrees Celsius. So, then you know this particular device also housed a hygrometer to monitor the relative humidity of the air. So, these data are very important in various equations, when I was discussing evapotranspiration, these temperature data are used to estimate evapotranspiration.

The wind is another very important parameter for estimating evapotranspiration. Now, wind causes the transport of water vapor from the evaporating surface to a particular direction. So, when we are interested to know what is the direction of the wind. So, this can be measured by or this can be determined by using Wind Vane. Now from which direction wind is coming, suppose there is a vast water body that exists in the nearby field.

So, the water body will transport if the wind is coming from the water body and it is coming. So, we will have the effect of a cooler environment in that particular area. That will influence

the evapotranspiration or vaporization of the water molecules and this will affect the evapotranspiration. If it is say the surrounding area where we want to measure and the direction of the wind are having a place where a lot of you know desert or without cropland exists there.

So, the environment or the microclimate of that particular area will be different and it will have a drier climate, and that will that is going to affect. So, the direction of the wind is also equally important when we are estimating or when we want to know the influence of the wind on the evaporation process or vaporization process. As I told wind is one of the important components of metrological data and wind causes the transport of water vapor.

Now the amount of the transport of water vapor will depend upon the speed of the wind. So, wind speed is measured by using an instrument called an anemometer. Now in the anemometer, there are three cups, these three cups are hemispherical. And when a slight wind comes, this causes these cups to rotate around their axis. So, the number of revolutions it takes in a given time is directly proportional to the wind speed. In the previous class, I was telling about the estimation of evapotranspiration and particularly for determining the pan coefficient.

So, the value of the pan coefficient depends on the wind speed and relative humidity of the area. So, it is one of the important components, and depending on the magnitude of the wind, the transport of water it takes place, higher the wind speed more will be the transport of the water vapor.

Solar radiation and the total daylight hours that are sunshine hours are another important components for evaporation and evapotranspiration or photosynthesis activity of the plant.

So, how many hours in a particular day in 12 hours period, how many hours sunshine exists, can be measured by Campbell Stokes Pyranometer. So, here what we see there is a ball which is made up of a glass of 7.5 centimeters in diameter. And then below this ball, there is a curved surface on a frame on which this particular chart is placed. Now, this particular chart is placed.

And this chart practically what happened depending on the movement or position of the sun, this you know when it is rotating when the movement takes place that it is because it focuses in such a way that it burns the paper. So, a number of hours total sunlight daylight hours are there, that is you know coming here as a burnt part and this value is used in many calculations of evapotranspiration or also this value is used for finding out the evaporation from a water body, evaporation from the soil surface. So, this gives information that how many number of hours on a particular day the sunlight exists.

Measurement of rainfall by using a rain gauge is another piece of equipment in any agro-meteorological observatory. And in all the agro-metrological observatory Simon's type of rain gauge that is a non-recording type of rain gauge is used. Now, this rain gauge is a standard size of the funnel and it has a 127-millimeter diameter of the funnel. So, whatever rain is captured by a non-recording type of rain gauge is collected in this funnel.

Then it comes so this is the bottom part of the funnel then it is collected in a cylinder. Now, the amount of water that is collected in the cylinder is measured by using a standard measuring cylinder. And this measuring cylinder has got 200-centimeter square area and volume or depth of water we can see the depth of water that whatever it has occurred in 24 hours is measured by using this cylinder.

So, here it is a graduated here, the graduation scale is shown the 1 to 11 numbers this can be seen. Now, these numbers are nothing but the depth of rainfall in centimeters in a particular place. Now it may happen during the active rainy season then one has to take observation two times or three times during the day in 24 hours.

Soil temperature is another parameter that is used to find out soil heat index also how much is the soil heat flux it takes place and which direction and at what depth suppose there is soil moisture at a certain depth, this will influence the soil temperature. So, these are placed at different depths and this is made inclined so that it becomes easier to know that what the temperature of the soil is. So, these are kept 15-centimeter, 30-centimeters at depth or it can go below 30 centimeters also. So, this is a manually recorded soil temperature observation.

And this is used for many research studies, how much is the soil heat flux it takes place, which direction, whether the up to what depth the atmospheric temperature which is influencing the temperature of the soil. So, it will depend upon the porosity of the soil, it will depend upon the compactness of the soil, it will depend upon the bulk density of the soil that is making difference but the influence of the moisture content influence of the vegetation that also makes a difference in the value of soil temperature.

These data can be recorded manually and also they can be recorded you know by in the digital form by using a soil moisture sensor. So, this is a sensor-based soil temperature monitoring. So, there is one sensor that is a place that is 30-centimeter depth, in this one, this is a soil temperature sensor. This sensor is basically for knowing the leaf temperature. So, leaf temperature, soil temperature, air temperature, these permissions are important for many research studies.

Here we are seeing a Pan Evaporimeter. Pan Evaporimeter is 125-centimeter diameter, it has a depth of 25 centimeters and it is placed over a wooden plank platform and is placed at a certain height above the land surface. So, that the transport of air can easily takes place and there is a minimum influence of earth temperature or soil temperature on the pan.

Now, the water in the pan is you know is filled up to 20 centimeters and the amount of water evaporated from the pan it depends on the solar radiation, temperature and as we see this is the surface, at this surface, the temperature is just near the surface is lesser as we go higher. So, this makes a temperature gradient. So, saturation vapor pressure and then here the vapor pressure of the air at the lower temperature, higher temperature, this causes this vapor pressure difference.

So, this vapor pressure difference causes the movement of water vapor in the atmosphere. So, in 24 hours whatever amount of water is lost from the pan gives an indication in the ceiling well, ceiling well is practically it is meant for showing the what is the amount of water it is lost due to evaporation. So, we are measuring the loss of water and then refilling bringing it to the original position.

Whatever it is their so there is a device where we are filling in the evaporation pan and this is practically one bucket in which the water is filled. So, amount of water which we are filling. Here, you can see there is graduation where graduation it is so that the how much amount of water is being filled into the pan. So, we can see here 0 centimeters then 1 centimeter, 2 centimeters. So, that means any amount of water which is lost, that is directly one can know.

So, this we are every time whatever amount of water it is lost, we are refilling. So, in 24 hours these observations are of all the metrological gauges it is taken three times in a day normally it is three times in a day. So, 7:30 am, 8:30 am as per the IMD recommendation, and 2:30 pm. So, means the pan evaporation data are taken at 8:30 am. So, the amount of water lost in the last 24 hours is replenished by filling the tank using this particular bucket.

So, in this bucket it is already graduated bucket and where these graduations, so that how much amount of water we have filled into the pan. A screen is placed over your evaporation pan to prevent the entry of birds or any other animals. So, though this screen influences the amount of evaporation so, we are required to correct it. But this is required to keep above the pan.

So, that birds or others they do not disturb and we can get correct observation at the end of 24 hours. Now, the surrounding conditions of the pan also influenced the pan evaporation. For this, we are required to know, what is the surrounding conditions when the wind is blowing. So, from which direction the wind is coming, and then what is the surrounding where there is a grass or there is some crop is grown in the adjacent area.

So, at what distance is this adjacent area this crop is being grown or it is all-barren land. So, this influences the value of the evaporation which is taking place from the pan, and accordingly, the pan coefficient is used to estimate pan evaporation.

We have seen equipment where the data are recorded manually, we have seen a rain gauge, we have seen pan evaporimeter, we have seen the data which are wind speed, sunshine recorder or maximum and minimum temperature.

So, those data are recorded manually. In this case, what we are seeing here is automatic data are recorded for all these parameters rainfall, maximum temperature, minimum temperature, relative humidity, wind speed as well as solar radiation. So, all these data are recorded by using sensors in the digital mode data are put up recorded in your data logger. It can be downloaded by connecting and also it can be transmitted to the server.

So, this is the arrangement which we have. Now in this one the sensors which what I am showing you here, we have got a maximum temperature, minimum temperature as well as dry-bulb air temperature. Also, wet bulb temperature and hygrometer sensors are placed there and this is connected with the data logger. Then we have a Pyranometer and this Pyranometer data is also recorded what is the solar intensity? and then it is coming to the data logger.

On the top, we see there is a wind with an anemometer sensor that records the direction of the wind as well as wind speed. So, here this is a data logger and then this data logger is getting the power by using this battery and this battery is charged by the solar panel. Now, the entire thing that you are seeing here is the wind speed and wind direction, this is a particular type of sensor, where it is there and then there is an arrangement for monitoring the rain gauge.

There is an arrangement for monitoring the air temperature, global radiation, and then there is a GPS antenna where this particular station is installed. So, all the data are hooked and then is going to a particular server where these data are saved. Then there is a solar panel that provides power to the system. Now, we have in the previous manually recorded recording data.

We had a Simon type of rain gauge before, now this is a recording type of rain gauge which is working like on the principle of a tipping bucket. So, the water which falls in this particular cylinder cup and this water it comes to a particular position. So, when the water falls over there and this will make a particular count, once it comes to this position. I am not putting it here because the data will be going there.

So, that will not be correct to get data because this is going to the main server. These are tipping buckets. So, one bucket is this one and this is another bucket. So, once it tipped and then the number of these tips it makes that it countered and that counted means equivalent to a particular size of the drop which is equivalent to 0.2-millimeter rainfall.

So, a number of times it takes it gives that how much what is the depth of rainfall in a given time, it had been recorded. So, this type of tipping bucket rain gauge is a recording type of rain gauge and then data are recorded. So, these are giving more precise values and correct values, and then without coming in contact with the instrument, one can from the remote distance, one can know what is the metrological parameter of a particular place.

One can know and then according to those data that can be used for irrigation purpose that can be used for estimating the evapotranspiration or various you know water balance studies hydrological study that can be used.

So, in the field laboratory, we have seen various instruments where we saw temperature monitoring instrument, thermometer, which measures minimum temperature, maximum temperature, wet bulb temperature, dry bulb temperature, for monitoring wind speed and direction. We also have seen sunshine recorder, you have seen rainfall measuring gadgets that rain gauge recording as well as the non-recording type of rain gauge.

You have seen an automatic weather station. And in a forthcoming lecture, we will also demonstrate you Lysimeter.

So, you can refer some of these books for more detail about these instruments, and thank you very much.