Natural Resources Management (NRM)
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Lecture - 40
Precision Farming and Protected Cultivation and Simulations Application in Agriculture - 3

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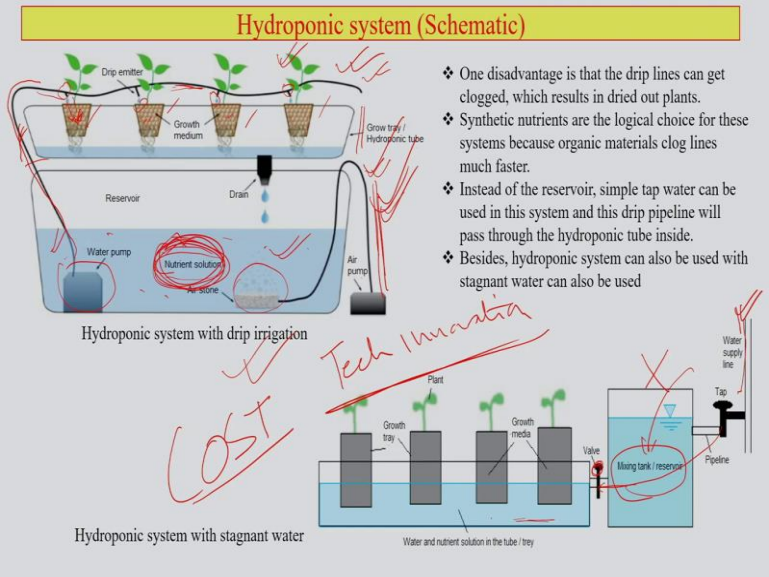

So, continuing from previous lecture on the topic of precision farming and protected cultivation and simulation application in agriculture and natural resource management, we will discuss today another you know aspect of hydroponic system that we have been discussing since the last lecture.

So, as I said in the previous lecture that you know under protected cultivation or precision farming, these are the new system of cultivation which are getting lot of popularity but please note that, that this kind of system where it is you know almost soil less agriculture system that means it is away from the natural system of agriculture. There is always a concern of cost associated with it. So, it is the challenge for all of us to invent or to modify the existing technology in such a way that we can reduce the cost of this particular system because as technically these systems are quite efficient and certainly would help our resource poor farmer.

Now, if you see that this particular hydroponic system here. So, you have actually this particular system with hydroponic system along with drip irrigation. Now, I am sure that you can recall that one of our previous lectures we discussed about drip irrigation in great detail. So, how now, drip irrigation can also be integrated with hydroponic system, this particular schematic diagram actually demonstrate that.

So, you have a system which we call grow tray or hydroponic tube where you have this kind of small pot along with the plant and then you have the growth media inside this. So this, things we have discussed in previous lecture. Now, what is the difference or addition with this system is the drip irrigation system. So, this is an extra addition to that. Now, here we have the water tank and then this water can also be mixed with nutrient solution and then you can have a air bubbling system here to diffuse the air into the water system like you might have seen in aquarium in our houses.

So, you have a water pump here. So, this water pump will help to pump the water into this pipe. Now, this pipe will have a small outlet which we have discussed in previous classes how drop by drop you know through this kind of system water can be actually given to the plant right at the point where they require it. So, this drop by drop water can be put inside this container a growth medium carrying this plant so that exactly that amount of water you give to the plant which is required for them to grow.

So here, you are bringing two type of precision agriculture or farming system one is drip irrigation at the same time you are also bringing hydroponic system which also comes under protected farming system. Now, yes this is a very efficient system and you can see that how we can avoid the excessive use of water. Water is a commodity that I think we cannot afford to lose any further. So, maximization of water uses is going to be the deciding factor in coming days.

Now, there are few disadvantages also associated with this one is that the drip lines sometime as I discussed in previous lecture these tubes sometime can get actually cloaked and then if you are not monitoring it, see I mentioned in previous lectures also that these kind of advanced technology which are highly efficient in utilizing natural resources like water. So, they demand actually regular monitoring. So, if you monitor it then they will serve you for long time without any problem. Little bit of maintenance can also avoid you know large expenditure of repairing or maintaining the system.

So, this type of pipe sometime as I said that can get clogging and because of that if you are not monitoring it on regular interval these plants will not get the required water remember in drip irrigation we are giving drop by drop water. So, that means in the media there will not be any excess moisture for the plant. So, if it stops for some time then certainly plant will suffer out of water that is an issue.

Now, synthetic nutrients which actually we put in these water synthetic nutrients are the logical choice for this kind of system the reason is that organic materials can actually clog this kind of pipeline much faster. So, instead of that you can put a nutrient synthetic nutrient in the water and in solution form it can go along with the water and then drop by drop get actually inside the medium. Then instead of the reservoir, simple tap water can be used in this kind of system and this drip pipeline can pass through the hydroponic tube also.

Now, if your water tank or supply of water into this reservoir is not very regular or suppose that there is a problem with you know manpower to regularly monitor this water flowing into the tank; whatever reason. So, instead of that this kind of reservoir tank simply with the supply water also you can connect but in that case you have to also find out that how this nutrient solution you can able to supply to the media or to the plants.

Apart from that, hydroponic system can also be used with stagnant water. Means after rainfall suppose in some places you have some stagnant water. So that, water also can be utilized for drip irrigation or hydroponic system. So, this is the one that I was talking about. This is your water supply line suppose at your home or any place where you are growing plant. So, you have a tap here this is the pipeline this is the reservoir. So, from this the water will come into the reservoir you can mix the nutrient solution as shown here and this is the valve.

This you can regulate to go the water from the reservoir into this water nutrient solution tank. So, your supply from the main line can come into the reservoir but if you do not have it for some reason you can straight away connect it to this water nutrient solution tank also, from there then rest of the thing is like this particular schematic diagram.

So, as I said that that this kind of hydroponic system along with integrated with drip irrigation system can also be tried and in that case you can also minimize the uses of water. But there is also option that if you have stagnant water in some places then you can actually use also this kind of system quite efficiently but remember that you need to be careful about the dirt or especially the dissolved solid into that stagnanted water. Because if there are too much of

dissolved solid or contains lot of you know material from outside, then though they can actually close your, this pipeline.

So, this pipeline if get close then water will not come to the plant as I already discussed. Otherwise this system is quite efficient system and this is an option for future also we have but again I repeat, the challenge is cost. How to minimize that and there what we need technology innovation.

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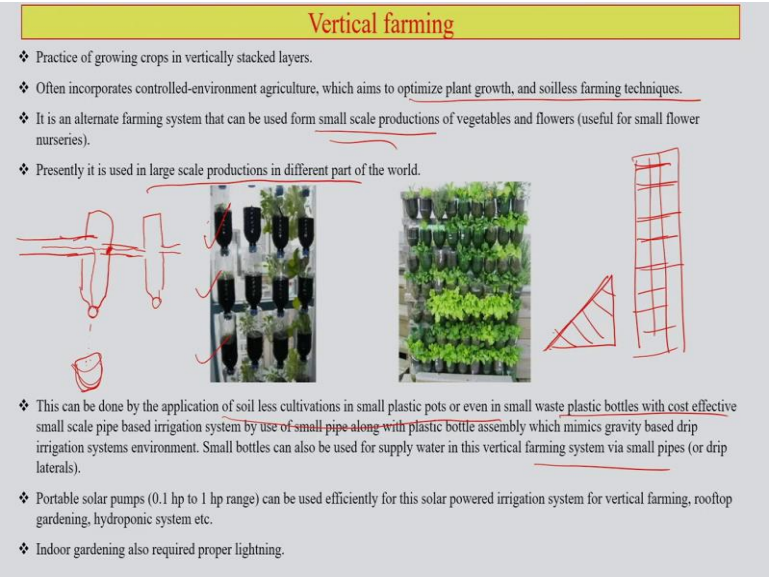

So, all of us actually need to work more on that, because certain systems are already available.

Well many of you might have heard or knowing about vertical farming this is getting a lot of popularity across the world especially countries like Singapore, Canada, Australia, USA. So, they are very much into this farming because they have also very tall building for their residential and official purposes.

So, this kind of building they actually try to use the spaces for farming and in India also you will see that some of the airports, some of the big corporate offices including some of the institute. In fact, here at IIT Guwahati we also started this initiative in a small way, you know somewhere inside the campus in one of the buildings but the thing is that as I said hydroponics, vertical farming this futuristic all farming technology require very frequent monitoring. They may not require regular maintenance but the monitoring because if you monitor a little bit of cleaning or supply line check then it can actually work for long without any major expenditure involved.

Now, vertical farming it is a practice of growing crops in vertical stacked layers. So, you can have actually this type of vertical layers or you can have also you know this kind of triangular shape vertically going up and or slightly going up. So, various kind of design as I said that in some of the airports, if you pass through you will be able to see that this vertical farming basically the concept came from because increasingly across the world we are losing the land, we are losing you know valuable lands to other purposes for other uses.

So, I do not want to get into those debate whether those uses are more important than growing plants or not but yes everything that we need you know we have to somehow manage among all the available resources that we have but certainly land and water these two natural resources are very critical to our survival and they are increasingly going down and down as far as their availability is concerned.

So, vertical farming you will find that this technology often incorporates control environment agriculture in a sense unlike natural ecosystem or natural farming system that you see outside in the field, they are not like that. They actually try to optimize the plant growth and largely encouraging soil less farming techniques. As I said in the previous class this soilless culture of plant is getting increasingly popular because we are losing actually land and soil for various other activities as a part of our overall growth and development.

It is an also alternative farming system which can be used for even small scale productions of vegetables or flowers utilizing the building spaces or in some spaces even within an office complex. So, the concept is that utilizing the spaces within the buildings even within the constructions. So, that you optimize every bit of space and you grow this kind of plants so, that you can also earn some money or overall that you know some concept is coming. Within the complex of a company in their building, they are growing certain green crops salads and all those things and they are utilizing using it for their own consumption within their office premises.

So, that kind of culture is also coming up and its pretty new in our system but this works nicely. You would see that presently a vertical farming is also used in large scale productions largely in the developed country, where you can actually utilize a significantly large area you know space or constructions areas where you can utilize for relatively higher number of plants. Vertical farming can be done by the application of soilless cultivation in small plastics like you see that, these are the plastic bottles which are after drinking we throw it. Instead of making generating plastic waste you can actually recycle it for vertical farming.

So, this kind of example you will see at individual level, at household level in many parts of our country these days. So, small plastic bottles with cost effective small scale pipe best irrigation system can also be done and there are also some places where people are trying small bottles for supplying the water in this vertical system through some small pipes. So, literally those bottles actually help them kind of a indirect manner of drip irrigation.

So, these are the pipes and this is supposing your bottle and supposes this is the bottle mouth. So, the water will come here and go here and then drop by drop will you know come into the pot or the carrier having the plant. Here also you can basically have another pipe if you want to make continuous. So, then this part we have to also make a hole here. So, the excess water from here will pass through straight away to another bottle. So, in this manner you can have you know a continuous system of utilizing small bottles for having drip irrigation into the vertical farming system.

Then portable solar pumps also some cases people used efficiently for this you know solar powered irrigation system. So, they use the pump to pump the water from suppose one somewhere some small tank inside the building; utilizing the solar energy and sometime they can also go for rooftop gardening through hydroponic system which is very popular in some parts of our country like Bangalore. I have seen that and maybe some other places like Bombay, Delhi can also have.

So, ideally vertical farming is a concept as I said that that it allows you to use your construction places or spaces or building spaces because if you cannot grow, it if you do not get the land to grow at least in small scale for your individual consumption, you can grow certain vegetables you know salads those things inside this kind of building space.

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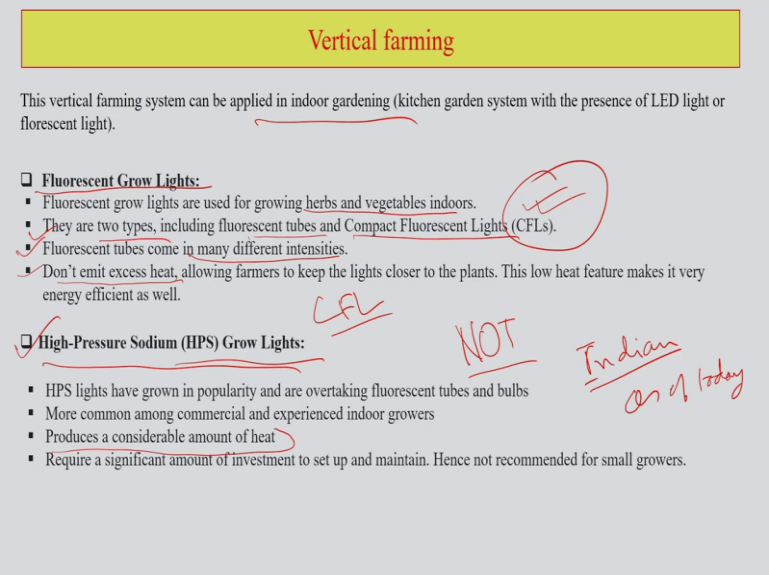

So, vertical farming is getting really popular these days. This can be applied as a part of indoor garden or kitchen garden as I just now said and then how actually you can do it. So, sometime Fluorescent light also can be used as an alternative for solar light. So, Fluorescent grow light actually can be used for going herbs or vegetables indoors. Again I just say that if you start with your own individual uses for a one small family then if every family start using that, then there will be a kind of a culture of having farming inside your building space.

So, Fluorescent grow light also, are of two types which includes the Fluorescent tubes and compact Fluorescent light we call it CFLs, which most of you know. Fluorescent tube can come in many different intensity and that we need to choose very carefully for the kind of plant that you are going to grow in that system. So, largely this kind of lights they do not emit excess heat and thus allow the farmers to keep the light very close to the plant and this low heat emitting system on lights also allow you to save energy.

So, see the concept of this kind of advanced farming system is taking care of your energy soil land water overall. If you look at those you know SDGs, the Sustainable Development Goals, this kind of futuristic farming technology very well actually attempts to address those kind of SDGs that in the world has set for us to achieve.

The next type of light source can be high pressure sodium HPS grow lights. HPS lights have become very popular and slowly they are overtaking the uses of Fluorescent tubes or bulbs. And these HPSs are more common among commercial and indoor growers like you know contract farming or some large you know online vegetable delivery company. So, these are new business ideas when they are coming. So, you will see that this kind of technology will get much more popularity.

HPS also produces considerable amount of heat unlike CFL. So, it requires also a significant amount of investment to set up and maintain. So, that is why you know HPSs is not recommended for resource poor farmers especially in our Indian condition at least as of or today.

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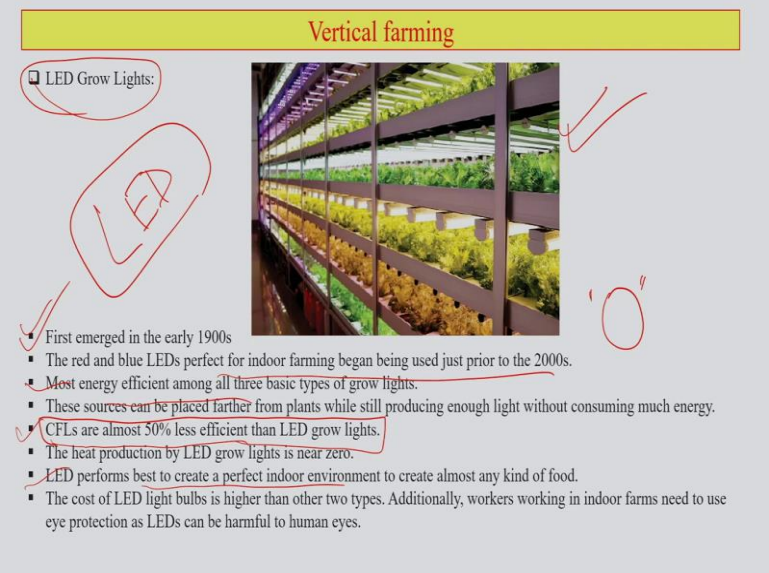

So, CFL still looks like an option that in our system we can go ahead, continue with vertical farming. Next is LED grow light this is also very popular some of you might have seen this kind of structure as I was mentioning that within an office space or airport or many other big building area this kind of things you might see in some of our airports.

So, this technique has come first around 1900 and the red and blue LED is actually the perfect system for you know farming for indoor farming and being used almost for last 20, 25 years. Most of the energy efficient lighting system you will find they are actually LED. So, our office spaces and many other places LEDs are these days being recommended more than any other form of light sources.

These sources LED light sources can also be replaced and they can be put easily far away from the you know the plants while still producing enough light without consuming much energy. So, that is one positive aspect of LED. That is why LED is getting much more popularity CFL are almost 50 percent less efficient than LED grow light. So, this is a most important criterion why LED is getting important in this kind of system or otherwise also. The heat production by LED grow light is almost near zero.

So, that is another very positive aspect because you know these days the green building green farming this concept means with minimum uses of natural resources you maximize your production that is the motto of todays. So, LED performs based you know to create relatively conducive indoor environment for any kind of food or any other purposes, if you want to go for suppose salads and other things which you directly want to consume you will see that

vertical farming is one of the very popular way that people are going for those kind of products.

The cost of LED light bulbs of course is higher than the other two types and also workers who are working in indoor farms they need to use you know eye protection because LED is harmful to human eyes. There are some report on that. So, directly looking at LEDs from a very close distance is not always recommended. So, especially for people who are working inside this kind of light sources just need to be little bit careful with their eye protection, that is one, only one precaution for vertical farming.

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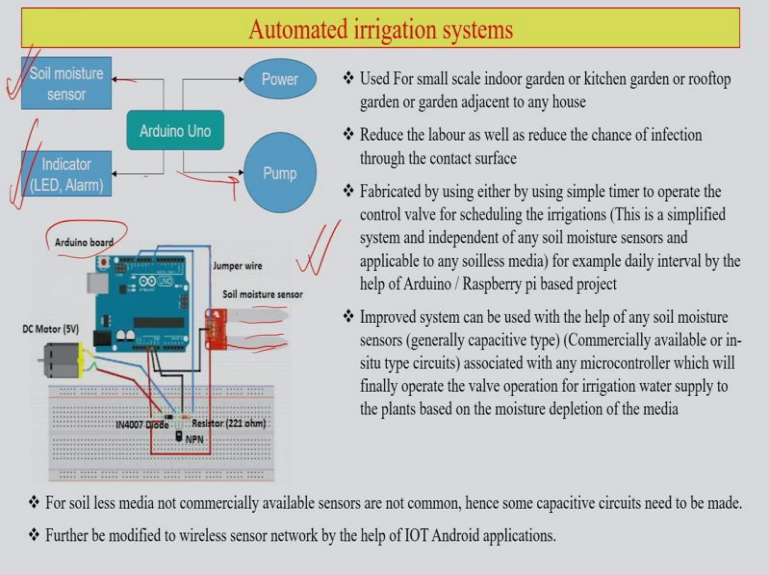

Now, let us talk about another interesting aspect and that is automated irrigation system. We have been talking about various kind of irrigation system and we talked about in great detail you know drip irrigation sprinkler etcetera. Now, today we are in the age of AIML. Artificial Intelligence Machine Language, IOT. Various kind of technology irrigation is one of the systems where most of the technologies from this field AIML or IOT are very interested to contribute in the field of irrigation system.

So, that is why, I will be discussing little bit about this automated irrigation system, how they work, what are the basic principles etcetera. So, when do we come to know that we need to irrigate? Means, when the soil goes below field capacity; means, the minimum amount of water or moisture that is required for a plant to survive if it goes below that amount which you can actually measure and experience people can even feel touching the soil, you need to irrigate.

Now, in most of the cases in natural farming system in special in our condition our farmers have so much of experience, they can even looking at or touching the soil can understand that this is the time to irrigate. There are also some system or indicators people use for irrigation like looking at the plant physiology and also growth stage wise irrigation recommended like a plant suppose a 90 days its life cycle. So, in that case particularly at what stages that you must give irrigation.

So, plant growth stage based irrigation also can be recommended but look at here. Now, in this particular you know schematic diagram how Automatic irrigation system can help us for irrigating our field or also suppose culture media in hydroponic system. So, in soil suppose you have a sensor soil moisture sensor which when the moisture goes down below the critical level it will give a kind of a indication or indicator through a light or alarm.

Then actually what happens is that here in the system, you will have a Arduino board which actually allows you to integrate the sensor the indicator and also decision system for starting the pump. So, the water can be irrigated in the particular site where it is required. So, this is a suppose the soil sensor which you can actually put inside the soil from here it will sense and the data will go here and then this information will reach through jumper wire into the Arduino board and from there then it will also generate a signal and that signal or indicator actually will be kind of a alarm for you know the farmers or a particular person.

So, there could be two way, one that if the alarm is seen then one person can put on the switch of the motor or the pump or the other way if you want to make it fully automatic as the system shows that, once the sensor gives you the data that water is less this is the time to give moisture then these information actually will go into the board and then will come back into the you know NPN system. From here the information will go into the DC motor and automatically the motor will be put on and then water will be pumped and it will be supplied in the place where it is required.

Now, this kind of automatic irrigation system is used largely for small scale indoor garden or kitchen garden or rooftop garden. At the field level of course you know at as of today in our condition still it is a kind of a dream but yes, lot of people including our institute IIT Guwahati also a team is working to develop some kind of automatic system where regulation or prediction of you know soil moisture irrigation can be carried out timely application of water also can be achieved.

So, this kind of system if it comes in it also reduces labor as well as reduces the chance of infection through the contact surfaces. So, only where you actually do not have enough manpower and where you actually want to do it in a very small scale, as of today this kind of system actually can be tried. This system can be fabricated by using either a simple timer to operate the control valve for irrigation for scheduling irrigation. For example, say daily interval that you decide that ten o'clock in morning and then I will have another irrigation say around three pm in the afternoon.

So, you can actually do in that manner as well and as I said that do you know Raspberry pi, this kind of system can help you to carry out this kind of exercise. Improved system can be used with the help of any soil moisture sensors which are commercially available and they are largely you know capacitive type of sensor. These are associated with certain microcontroller which will finally operate the valve as you saw in this picture and once the valve operation is taken care of your irrigation or water supply to the plants will also be taken care of.

For soil less media as we discussed just in in the previous like in hydroponics, soil less media you know the commercially you do not get that kind of sensors. But there are some reports where we find that some of the developed countries are also trying this kind of sensor to develop and apply it for also soil less media.

Now, wireless sensor network by the help of IOT you know all android applications also people are working on lot of research is taking place. As I mentioned here at IIT Guwahati also a team is working towards this kind of application.

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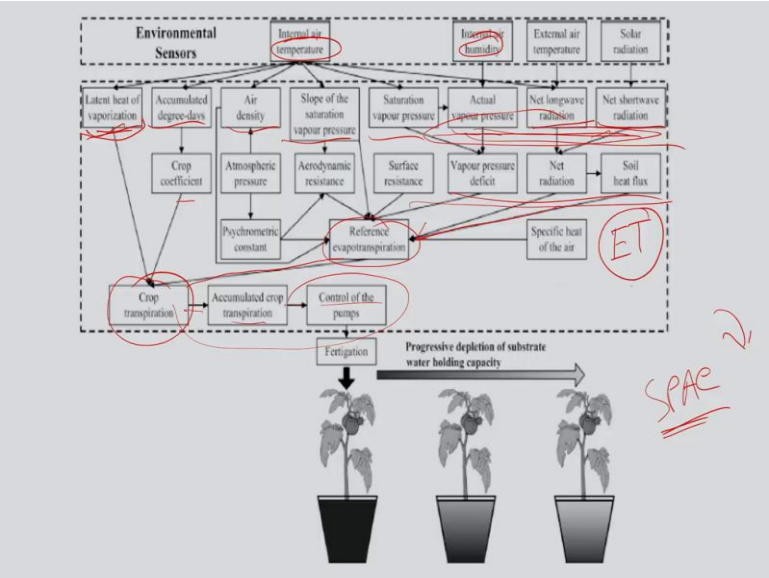

Now, this particular site is actually shows the different kind of sensors which can be used for agricultural farming systems applications and specially water applications. Now, if you see the different environmental parameters which are important for a plant growth; for those kinds of parameters sensors are actually developed. Now, what are the things that we need, temperature one of the most important parameter, humidity and these two parameter can easily be sensed through some sensors.

Now, internal air temperature suppose within a building space if you are going for suppose a vertical farming. So, in that case what is the internal temperature, the latent heat of vaporization, accumulated degree days, then your air density, then slope of the saturation vapor pressure, saturation vapor pressure, and actual pressure? All these information are actually various kinds of indicator or sensors that actually help you to study the plant growth. Now, few other aspect, are also important for say transpiration coefficient is also an important apart from the other parameter.

Now, crop transpiration which actually can basically have some linkage with sensing the moisture amount in the soil or in the other media where you are growing the plant. Now, in case of other sensors or indicators that we have here, long wave radiation net short wave radiation they also play important role. So, from these other sensors we can actually come down to you know some specific heat of the ambient air because those are the parameters which regulate again your evapotranspiration, ET.

Evapotranspiration is a phenomenon which actually associated with removal of water from the plant canopy into the environment. Of course if you recall in previous lecture I mentioned

about the system called SPAC. So, you know under the influence of pressure changes, low pressure or high pressure situation either you know in case of low pressure if the humidity is already there into the ambient environment certainly the plants will find difficulty to transpire it into the environment. But if it is high pressure where outside environment is dry, very less humidity, then definitely the plant canopy will be able to transpire the water pretty much easily into the surrounding environment.

So, in a sense that these are the heating parameters or radiations etcetera, they actually regulate your evapotranspiration. And if regulated then they can actually ultimately decides that when the soil will be dry and then you need the irrigation for those plant. Now, all these things can be automized to make this kind of automatic system which takes lot of innovations and also studies to mimic the conditions of the natural system but research and innovations are going on in this line for many years.

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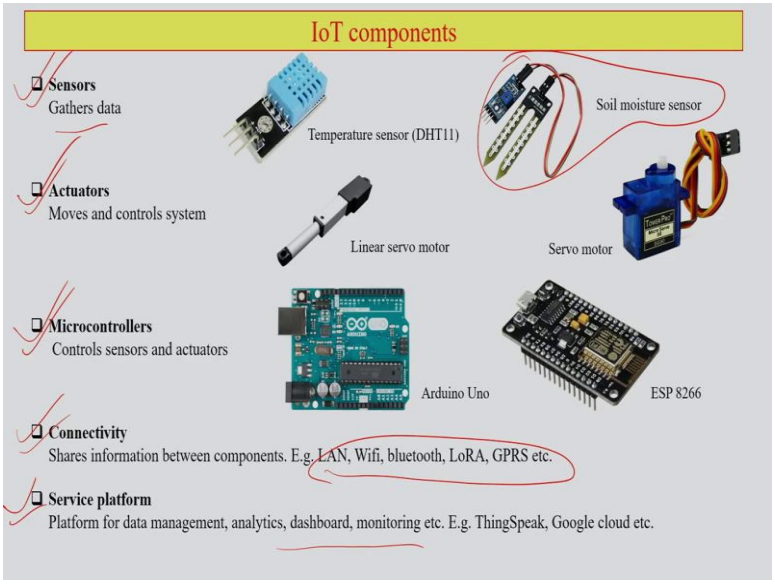

Well these are some of the components, that are being used for making automized farming system and it has become a very popular in allied area of research and interdisciplinary research between artificial intelligence experts and agricultural experts working together towards you know application of this advanced technologies for development of efficient agriculture. So, IOT components like sensors, actuators, microcontrollers; then for connectivity we need LAN, Wi-Fi, Bluetooth etc. Service platform you know we can need different kind of dashboard monitoring.

So, the good thing is that most of these instruments are available in the market. So, this is the soil moisture sensors people use for this kind of activity. So, essentially the situation is that

we have. Now, in reached a state where this kind of you knows advanced technologies must be try attempted to apply in the field of agriculture where natural resources required in significant amount. So, to maximize or enhance the efficiency of natural resources like water land etce, I think that this advanced technology also could play a very important role in the days to come.

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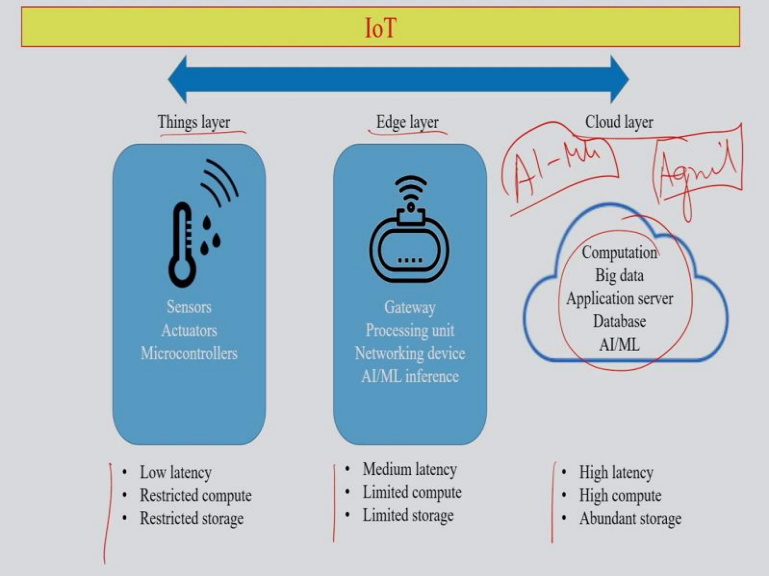

Well IOT, you have been listening about the application of IOT in various fields. So, in natural resource management also they are playing a quite significant role. Now, these are different kind of layers in case of IOT you will find. So, cloud layer of course is computation where you need big data and application of huge amount of data. Then you can go for cloud layer and every layer or system has certain restrictions; a certain particular domain within that which they can be applied. Essentially very soon in near future somehow I sense that we are going to see you application of IOT and AI/ML in a very significant manner in the field of Indian agriculture.

Now, the scale of the application on the scale of the utilization of this technology in the real farm situation that might take some time. Obviously you know that to make it a success we need to again you know once it works then we have to work on the cost part of these technologies.

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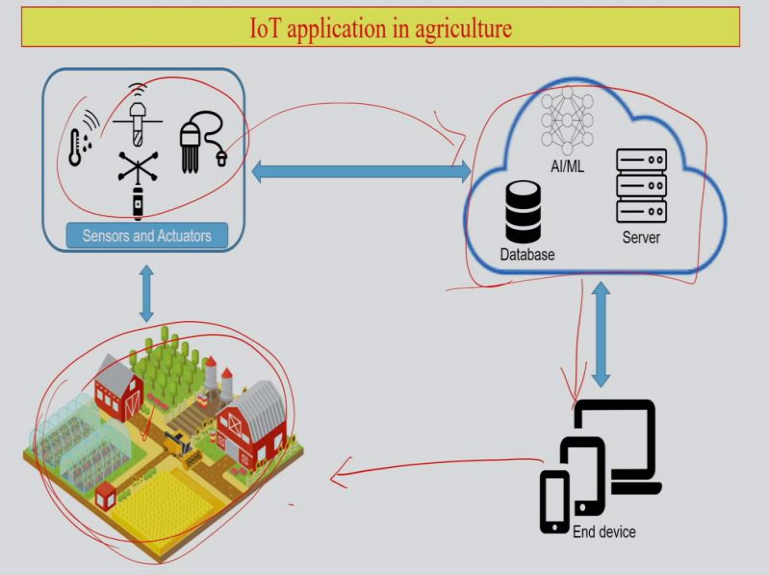

So, otherwise as a technology it has potential in the field of natural resource management. So, this is a very simple of schematic diagram that how IOT can be applied in the field of agriculture and natural resource management. So, this is your field and you can have various kind of sensor into this field and suppose that you are an owner and having only two three persons to look after the entire area, then I think that IOT application would be a very effective one.

So, they use also database server, where the information from this sensor will go and ultimately from this database you can utilize those information and then process and then from there, ultimate you know the decisions goes to the ends. So, these are devices which ultimately will work and help you to grow different kind of crops within a system and utilizing also less manpower.