Farm Machinery
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Lecture – 16
Equipment for precision planting

Welcome students for this 16th lecture on Equipment for precision planting. Well, before I go a details into this I think it is very imperative that I should talk about what precision planting is. Precision planting you must have seen that so, far we have been talking of application of a more and more fertilizer and getting more and more yield over the years. And, now a time has come that we are getting negative effect of those fertilizers which have been applied in several parts of the country and the world.

And, then we have we have started thinking as to what is to be done. What sort of fertilizer to be given? What amount of fertilizer to be given? Then we are also thinking because, the area has shrunk and we know that the population I discussed in my previous lectures that the area has decreased and the population is exploding. We know that by 2050 the whole world will be some 9.1 billion people and in that context it is very essential that we must look into all the resources that we have; with respect to the infrastructure, with respect to crop production, with respect to the other inputs in crop production.

Because, we want more and more yield to feed the population which is increasing. In that context it is very important that we do think of each and every input that we have with us for crop production. It starts with the tillage energy itself, we are looking for equipment which should give us minimum passes of the equipment for getting the soil tilth which is required for giving a proper environment to the seed so, that the seed will grow.

After that we are looking for a good quality seed seeding mechanism, seeding equipment by which we should be in a position to put only the exact amount or most optimum you can say amount of seed which should be put. So, that it gets a better environment and it is not that earlier we are thinking that ok, let us take two 120 kg or 130 kg per hectare of a seed rate well then what is important is we must know what exactly is required. So, we need to know what is the amount of seed similarly, with then we will think of the machine energy, we will think of the fuel energy, we will think of completion of the

operations in time because, then we need to take another crop because, the old time is fixed of the year.

Within that period we have to take several several operations to be completed so, that we get maximum output from the field hence, increasing the cropping intensity. So, all these inputs need to be thought of in the precise manner and to be applied in a very precise way and for that you need to get proper equipment. So, we will just talk of the equipment for precision planting, we will talk of planting. You have learnt earlier that seeding and planting slight difference is there.

Because, when we are talking a planting it could be that we are maintaining a seed to seed distance or a hill to hill distance. Sometimes we also talk of transplanting; that means, planting has been done at one location of certain size of seedlings and those seedlings are picked up and then planted in the real field, where they grow and actually come out as a big crop and we get the yield out of that. So, in that series we will talk of precision plant planting. So, let us look into this what this precision planting equipment is, we will talk of one equipment at this point of time.

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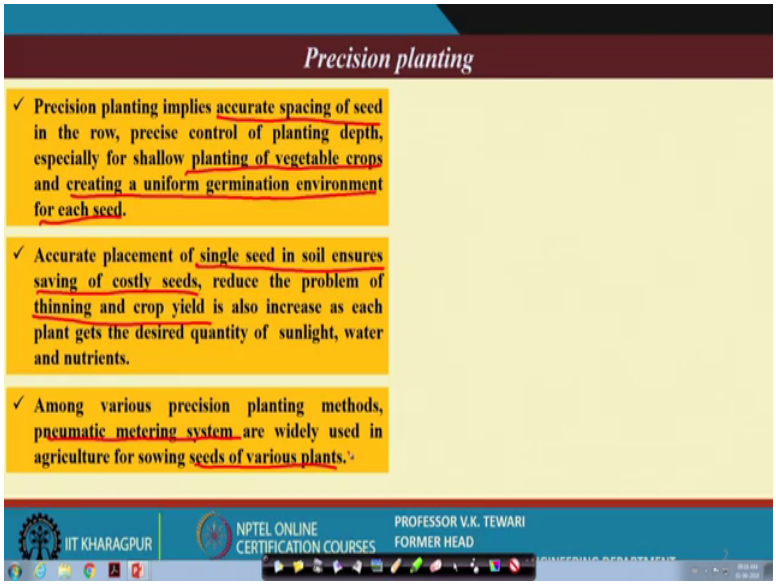

Well, precision planting implies accurate spacing of seeds, yes accurate spacing of seeds very very important or planting or planting of vegetable crops and creating a uniform germination environment for each seed. This is very important this is what we mean by precision planting. Accurate placement of single seed in soil ensures saving of costly

seeds sure as I discussed at to you, reduce the problem of thinning and cropping, yes it will because if you have put lot of seeds; then a time may come when you will require to thin this and such that there will be control on the weed growth.

Because, those weeds are also going to come compete for the nutrients within a crop plant as well, that is why we have to think of proper breeding operation as well. Therefore, this is very important. Among various precision methods the pneumatic metering system are widely used for sowing seeds of various plants. Now, this is one the pneumatic one is more precise among the other various types.

In fact, I have also shown you in my field operation about the equipment. We will talk some more details of this and it is very important from a designer's point of view, you will be all designers. At some pointer the other you would like to design a particularly equipment pneumatic equipment, you must know what is the type of equipment? What are the essential features which is the particularly equipment should have and what are the important formula etcetera which are required for that. So, let us go into details of this procedure equipment.

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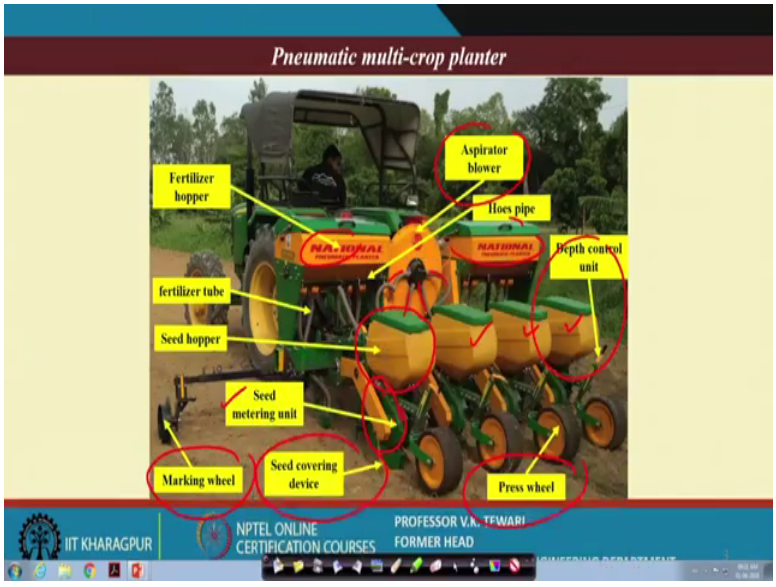

Pneumatic multi crop planter, yes I have shown this thing in the field to you already, but then it is very relevant that I should show you here also as to what are the more details of that of this particular equipment. Well, we will start with the last operation that is the press wheel. The press wheel, see this is the one which does the job after the seed has

been put in the soil a coverage has been given and the pressing wheels they are going and then they will press it to certain extent we require. So, that there is a proper mechanical impedance or a thrust soil thrust with the seed has to germinate for that so, we need to have press wheels.

Then the seed covering device, we go to the next one which is seed covering devices it once the seed has been put what is the covering device and how does it work. So, we have a covering device over here. Then marker wheel, this is another point which you must see that this marker wheel marks that we do not leave any portion of the field, while this operation is going on. It is very important for from that point of view.

So, this is a important item which should not be looked the upon and which should not be just neglected, this is very important. Then seed metering unit, well this is the seed metering unit here. Seed metering unit, how the seed is metered from its hopper where it is. Then the seed hopper, this is the seed hopper here. There are individual 4 hoppers as you can see, they are individual 4 hoppers. Now, there is a, this is a multi crop if it is also a fertilizer unit as well; that is why the fertilizer hopper is also given over here, over here.

Now, in the fertilizer these are fertilizer tubes through which the actual fertilizer will go and go into the location or at which it should be put while the seeding is being done on a particular location. I have discussed about this you may recall that what should be the proper placement of the fertilizer with respect to the seed. So, you may recall that and accordingly this fertilizer has being put when the seeds are being sown through this pneumatic planter.

Now, the depth control, yes we need to maintain depth control through this field. So, we have toggle of this because there it is very important that depth control should be there. And, if you go back we also discussed about the laser land leveller where, it is very important not only from the saving of water, but also from the point of view of saving of the unnecessary delay in movement of the vehicle or movement of the equipment when it is in the field. So, we would like to maintain the depth of operation. So, this you is there this is how we maintain. Now, aspirator there is a aspirator blower here.

Now, this blower you if you can see I I have shown you in the actual field condition, but see there are 4 tubes coming out 1, 2, 3, 4, these 4 tubes are coming out. And, this blower

is operated by the PTO power from the PTO. So, power PTO is operating this blower and from these tubes they are they are coming into the plates, actually seed metering unit this is the seed metering here. Now, what is there in the seed metering unit? We will discuss this next. Because, once the seed is there in the seed hopper it is open to atmosphere, this is one part of it. Now, when it goes to the soil it is again in the atmosphere, but in between how do we precisely take from the hopper and then put it back into the and into the soil. Now, between this what happens let us have a look at it.

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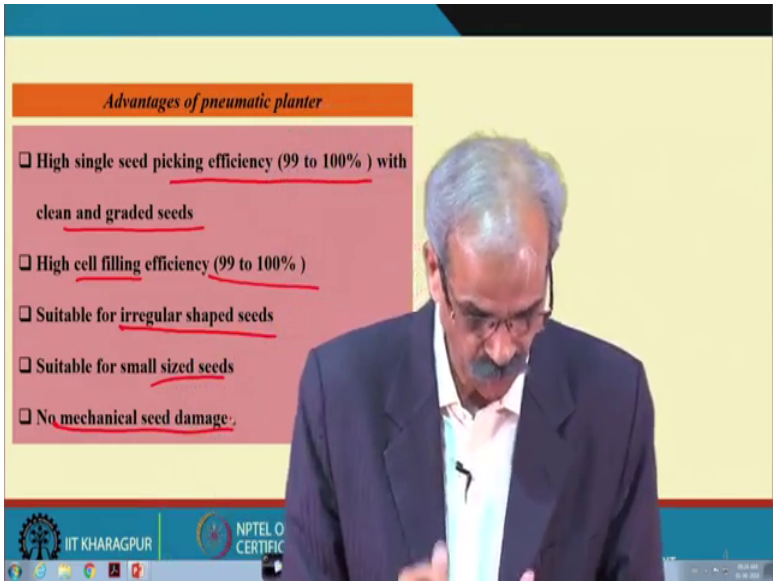

Well before for this pneumatic planter also it is essential to know what are its advantages. A lot of advantages are there as I told that we are very much interested and concerned about keeping the seed at the right place in the soil and in the right amount and right spacing. So, because we are going to get higher yield if we maintain this environment of the seed. So, what are the advantages that we get out of this? Picking efficiency, you will find the picking efficiency is 99 to 100 percent, it has to be because the moment we talk of precision we are talking of individual seeds. Irrespective of whether the seed is of what size, shape and all that, what is the size of this it does not does not bother about that. What is the shape of this seed and what is the size of a seed etcetera ok.

With clean and graded seeds yes, cell filling this is important that you should not have a missing. So, we will find that cell filling is also very high very you can see 99 to 100 percent. A irregular shaped, as I said earlier that the size and no mechanical damage this

is important, because see if I have put the seeds many times we also take care of the germination point of view viability. What is the level of viability of a particular seed? So, we take care of that germination percentage should be about 80 percent or 90 percent like this. Why do it? Because, there are there are a chance in that some of the seeds may be faulty or some of the seeds may get damaged when they are passing through the metric mechanism. So, particularly if you recall the metric mechanisms which are there when we have the fluted roller and other equipment other types of devices.

There are every chance that the upper portion of the seed may get damaged. There could be a superficial damage, there could be a ill critical damage because, the superficial damage may not lose yield, but a critical yield critical damage which will be responsible for yield. And, that will not happen in case of this pneumatic seed. This is beauty of that it will simply be taken from the hopper and it will be transported through air medium in into the soil.

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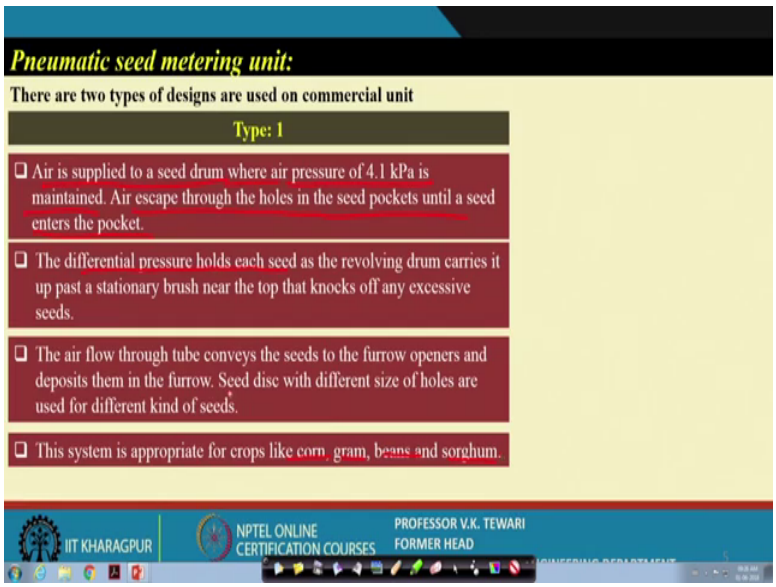

Well, in this there are two types of devices which have been available in literature. And, at this point I would also like to tell you that see, as a designer you must think of a third type or you must think of a mixed type or you must have think of something new. So, that even you can think of a better mechanism, better device, a smaller device, a more efficient device than what it is. Remember that no system is perfect, we can always think of perfection better and betterment of any system. So, while we tell you that what are

there in the literature and what not being invoke in the use; you must also think of something new. And, for that what parameters, what attributes, what design aspects you must consider we will discuss those things.

So, let us have 1 unit which is which has which it air is supplied to a drum where air pressure of this is maintained. I have shown you the drum already from this from the hopper. Now, you see that the air which is coming from the tube through the tubes which you have seen earlier those tubes are entering into a drum. Now, air pressure up about 4.1 kPa is maintained and air escapes through the holes in the seed pockets until seed the enters the pocket. Now, what happened there are pockets in this seed plate itself I will show you.

So, what air is passing through that and the air in the hopper is at atmospheric pressure and here you are passing the air at maintaining a pressure about 4.1 kPa. So, differential pressure holds each seed because, the moment there is a difference in here you are giving this much pressure 4.1 and the other side is atmospheric pressure. So, the differential pressure the moment seed comes there it will be held over there and that that goes on because, that will go along with this metering mechanism. At one point if there are more seeds taken then it will be brushed off and then single seed will fall. So, this is the system it is appropriate for some of the crops like corn, gram, beans, sorghum could be other ones which are smaller than which are required.

And, seed discs with different size holes are used here. This is another beauty that you can as we see discussed in the earlier slide that you can have size different sizes, different shapes etcetera. So, the this different sizes of holes etcetera are available in the disc these are available so, you they can be put. So, here is another aspect of design, you can think of a proper design of those seed pockets or those seeds sizes depending upon which seed, if these are meant for a particular smaller seeds. If you want slightly bigger size seeds, if you want certain oval seeds or whatever you can incorporate in the design and come out with a different design. So, this is the aspect of type 1.

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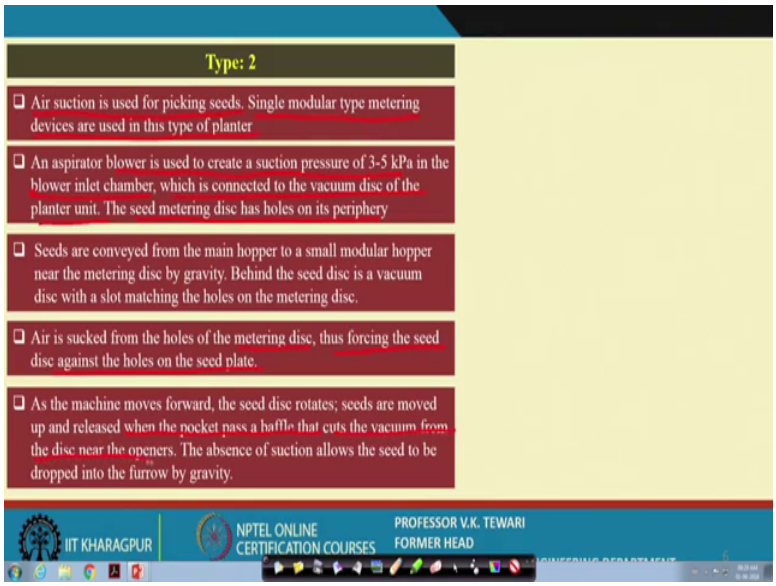

In type 2, a suction is used pic for picking the seeds. We would like to start from a in a drum where, the seeds rotate where the a drum is rotating and the suction pressure suction is created, a vacuum is created in a drum. And, that the device this is singular modular type metering devices are used in this type of planter.

Now, what happens is again the way we have maintained their here and the blower is used to create a suction pressure of this. This a suction pressure is here is because you would see that its suction is created out of the device in the drum itself. So, this suction pressure and the blower inlet chamber, which is connected to the vacuum disc of the planter unit. Now, this is connected to the vacuum disc of the planter unit. The seed metering disc has holes on its periphery.

It is important that the seed metering disc has holes in its periphery and the suction is created. So, they will be all held on the periphery of the seed plate. Air sucked from the holes of the metering disc, thus forcing the seed against the holes on the seed. As I said that yes there are periphery holes and the suction has been created. So, they will be just moving on the periphery and they will be carried on the periphery and when the pocket passes baffle that cuts the vacuum from the disc near the openers. So, there is location at the nephron is there is a baffle there. So, seeds are removed so, are moved up and released when the pocket passes a baffle.

Now, we will see this what it is there in x so, we have talked of two aspects: one where there air is blown and then there are disk and we are maintaining a pressure difference on the seed of atmospheric pressure on one side. And, the say 4.1 k kilopascal on the other side and there we are maintaining this one type of metering mechanism. And, where the seed is grown see when the seed is moving on the seed plate, it is brushed off if there are more number of seeds. And, only single seed is then dropped in the earlier case.

In the second case we are making make a maintaining a vacuum, as I said here and then in the vacuum in the periphery of the disc the seeds are there held. And, the moment there is a baffle which cuts off this the vacuum immediately the seed will be released at the end of the opener, at the location where it is supposed to go.

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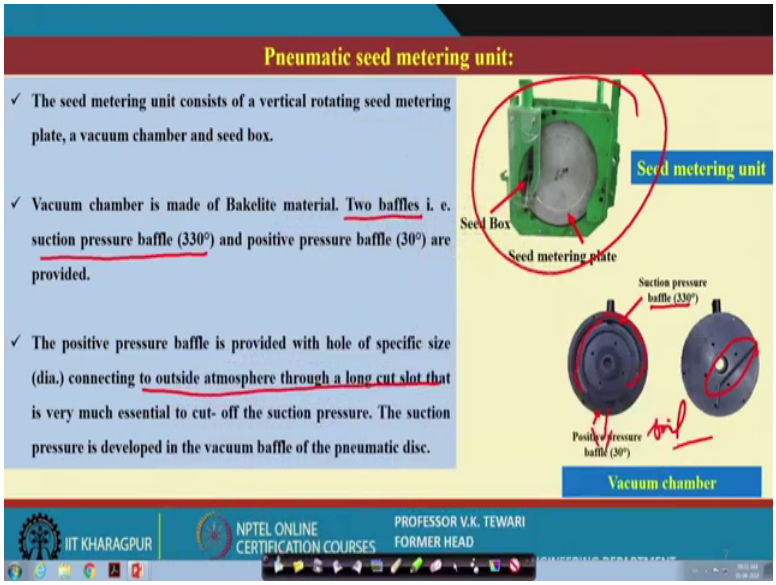

Yes, now this will clarify to you as to what exactly I meant over there. See so, these the seed metering unit, you see these the seed metering unit here. The seed box is here, this is seed metering plate and more details are given here, there is a suction baffle. Now, these suction baffle at 330, you see here the two baffles suction pressure baffles 330 degree maintaining 330 degree you can you can see that they are maintaining this. And, there is a positive pressure baffle of 30, now this is through connecting to outside through a long cut.

Now, this is the long cut that is there on the plates. So, what will happen is the moment the seeds come around this point along this point here they will be released because, this

will at is it relate related to positive pressure or to the atmosphere. So, the moment this comes here or these seeds will come over there this portion will be able to atmosphere and hence, the seed will fall and the seed will go to the soil. This will go to the soil. So, this is as simple as that.

But, you need to understand if you want to design a new device, you can think of what exactly is the pressure. In the literature we have talked of that the pressure of 4 should be maintained, somebody says that the 3 to 5 kilopascal you should maintain and things like that. But, for different types of seeds, for different shapes of seeds what are these values? How there should be um actual values to be maintained in a particular device, it is a concern for the designer. So, if we consider that this device which is already available may this is the method by which the whole operation takes place.

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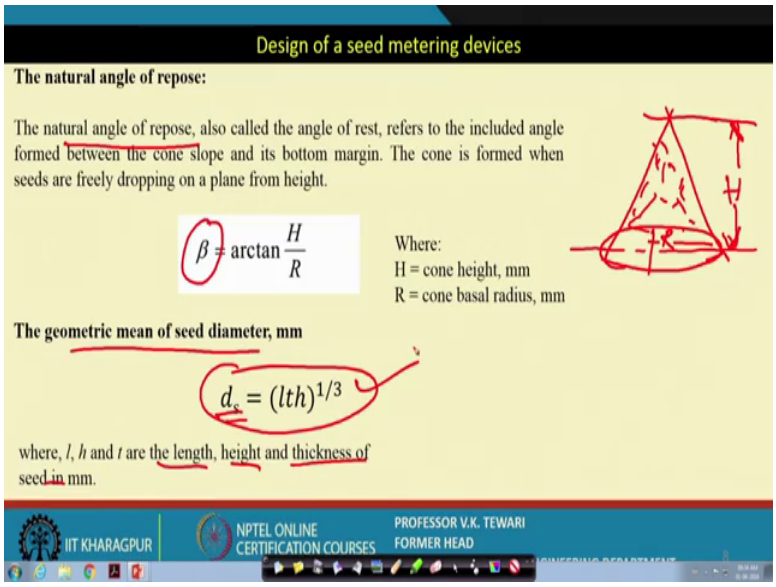

Design of seed metering devices well, here it is important to the extent of understanding certain things because, how will you say that the seed remain device is designed or how will you assume there is a seed metering device. See angle of repose, what is this? The angle of repose had to be with respect to seed, the angle of repose has to be respect to seed. Now, if you consider this is the say if I consider like this H and so, you see this cone height, this is the height of the cone, this is this.

When the seeds are actually this is what we are trying to create, that what is this the cone the angle beta, this beta angle is given as this very simple you get from simple geometry

you can see this that how we can get this. Now, about the seeds sometimes when we are talking of the seed metering devices we are definitely concerned about what is the common parameter of a particular seed, we have seed has a length, has a breadth, has a thickness. So, what is the common parameter which can be thought of can be taken for the design.

And, there we find that the geometric mean of this of the seed or geometric mean of seed diameter. Now, this is very simple when we are talking of the length, height and thickness of the seed. So, assuming this we know that the geometric mean diameter of the seed is can be given as this. These are important actually because, when you decide the factors when you decide the design you must have an idea about the seed metering device. When what is the type of seed, how do we take the parameter of the seed with us in the design.

And, the important parameters are this in the angle of repose of the seed mass when it is for and the seed size, seed size. So, it is one parameter we will take and instead of l length, thickness and the height etcetera. We would like to take a common parameter which is geometric mean diameter of the seed. Revolutions per minute, now how will you there are certain things which you must understand actually.

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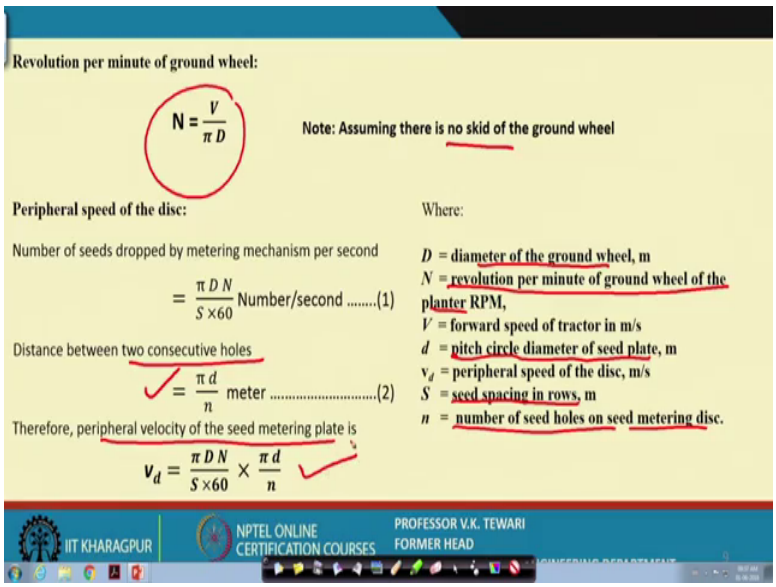

Revolutions per minute of the ground wheel, now you should understand that the tractor is and moving the ground wheel is the ground wheel of the tractor. But then we have also

the ground wheel from where we have taken the power. So, it is important that we assume that the that there is no skid of the ground wheel. So, we are assuming that the speed at which the tractor is moving same speed we will take for the for the metering mechanism we are talking. So, revolution so, here N is the revolutions per minute of the ground wheel of the planter in RPM, diameter of the ground wheel D is ground. So, from simple pi D N you will be in a position to find out this where, V is the forward speed of the tractor, V is the forward speed of the tractor.

Now, peripheral speed of the disk: number of seeds dropped by metering mechanism per second it is very simple; once you know that this pi D N is the distance covered and S is the seed spacing in rows by dividing you can simply get what are the number of seeds dropped per second. Once you know the number of seeds per day, the distance between two consecutive holes on the plate is important. And, that how do you get that? Because, you know that pi d is the pitch circle diameter of the seed plate, then n is the number of seed holes on the seeds metering device.

So, once you know pi d by n will simply give you the distance between the consecutive one as which we have shown over here. Therefore, what is we have got two things here the number of seeds dropped per second and here we have got the distance. So, if you multiply this you get what is called the peripheral velocity of the seed metering plate and this is what it is. So, in a very simple way I have tried to explain to you how you should consider the when you design a seed meeting device. And, maybe we will have certain numerical problems on this in the later course of deliberations on this. So, that it will give you more clarity on the on this aspect.

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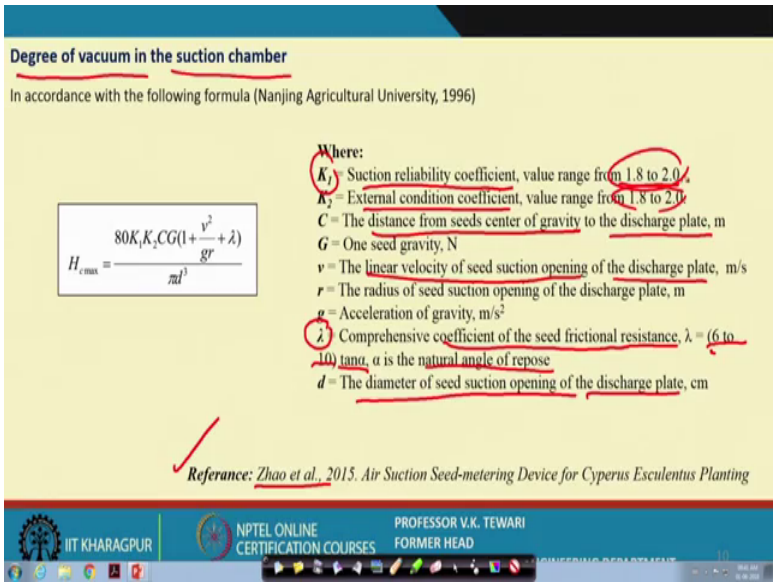

Well seed vacuum, actually I told you that there are seed vacuum values which has already been given in literature and I also pointed to you in my earlier slide. But then some researchers have as I told you that as a researcher, as a designer you must think of finding out values, accurate values for different sizes of seeds and equate implements and machines that you want to design.

So, one gentleman uh whose work we are quoting here Zhao et al, they have found out what should be the suction chamber degree of vacuum in the suction chamber in a particular, for a particular seed size or if a particular condition of the environment of the seed soil etcetera. Now, you these if you go to the details of this particular reference I particularly given this. So, that which is about 20 22 years back or so, but then if you go there is a way by which they have calculated. See suction reliability coefficient they have found out, varies between these two this on certain aspects certain parameters. External condition they have talked, they have also decided what is the external condition of the seed in which this job is done. Distance from seed centre of gravity to the discharge plate; that means, seed in the centre of gravity the seed to the location where it is disturbed and dropped. And, seed gravity one seed gravity as if when one seed is falling what is that so the values of K 1 K 2 C G.

Now, this is the linear velocity of the seed suction opening of the discharge plate. This is important because, we have discussed earlier what is the linear velocity in the previous

slide. So, that is important and of course, the diameter of the seed suction opening, how do these onto the discharge plate. Now, another aspect which they have talked of is lambda; comprehensive coefficient of the seed frictional resistance. Now, this depends on 6 to 10 times tan alpha which is the angle of repose. So, I mean it is it is why one must appreciate their effort here because, they have found out as to how what should be the degree of vacuum that should be considered and the way of doing.

And in fact, if you read the details of that you will find that they have found out for a particular seed and for all these conditions which they have designed; may be more details you can find out in the this particular reference itself. And they have found that the value is about 5.2 kilopascal or so. So, you may go to that and have an idea. This will also give you an encouragement to think of why 5.2, can we think of this K 1 on what basis these values have been thought of. I want what way to value this has been thought of, you can think of this design and contribute yourself as a designer which is the requirement today. We must question what is a particular person has done, not that we should say wrong but we should see what new, what best can be done.

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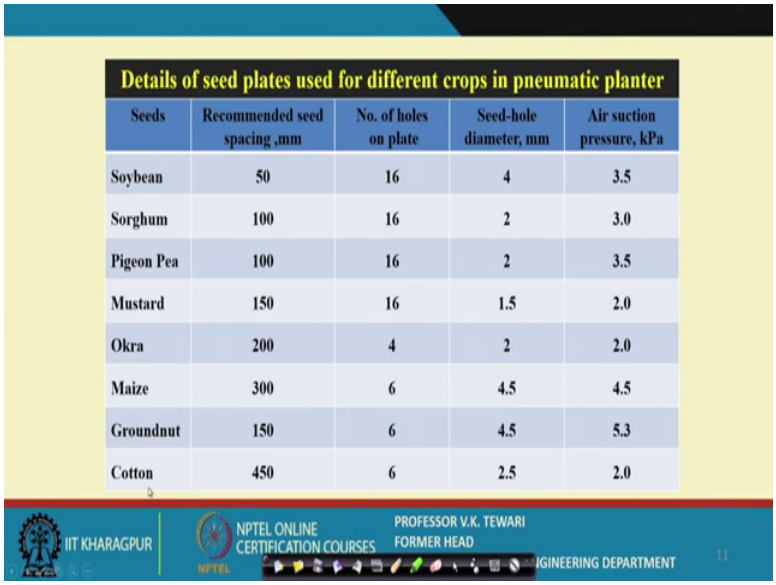

Details of seed plates used for different crops pneumatic planters as well this is information which we have taken from the literature. And, we would like to give you that some of the important things the recommended seed spade spacing for soybean, sorghum, pigeon pea, mustard, okra, maize, groundnut, cotton. These recommended seed

spacings we have given, number of holes on the plates which are generally there we have given, seed hole diameter also is given, air suction pressure is also given.

So, these are information which are already available in literature which we have given to you. But then, as I discussed as a designer you must look into the seed metering device, the pressure to be maintained, the size of the wheels, the size of the pressing wheels. Then the placement of the marker, then the side of the tube, then the design of the plate etcetera; you must think and then come to the details of a particular design. This will give you an input for your design when you are going ahead.