Design of Farm Machinery

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Lecture 27 : Components of seed drill and its calibration

Hi everyone, this is Professor H. Raheman. I welcome you all to this SWAYAM NPTEL course on Design of Farm Machinery. This is lecture 27, where I will try to cover components of seed drill and how to calibrate a seed drill. The concept which will be covered are theory of furrow opening, then what are the different types of furrow openers available, and calibration of a seed drill, different methods of testing, then performance parameters.

Now, first thing is theory of furrow opening and covering. Why do you require to open a furrow and then close the furrow? In tilled soil which is devoid of vegetation drying occurs at a faster rate because of the transfer of moisture to the surface and the soil moisture content increases with depth. So, on the top of the soil surface, there will be no moisture. Moisture will be there, but is very less and as you go deeper into the soil there will be more moisture available. Seeds require moisture for germination and growth and moisture transfer from soil to seed is promoted by placing the seeds in firm contact with moist soil.

Increased depth of planting thus promotes better moisture transfer to the seed. Choice of an optimum seed depth is a compromise. However, because two factors favour shallower planting. If you put seed into deeper depth, you require more volume of soil to be removed to make a deeper furrow and at the same time the germination is a problem that means, it takes more time to come to the soil surface. Now the first thing is that soil is normally warmer near the surface. So, we also require some amount of temperature for carrying out germination.

So, soil is normally warmer near the surface at planting time, and warmer soil promotes seed germination. The second is that a seedling may not, or a seed may not have sufficient strength to emerge if you are putting a seed into deeper depth in firm soil. So, thus there is a requirement that means we should put the seeds at optimum depth, which varies from crop to crop. And the other factors like your soil condition, whether the soil is too dry or

some moisture is available. So, all those things will control at what depth you are going to put the seeds into the furrow.

Typical planting depths I have given in millimeters: like corn, it is 40 to 65 millimeters; cotton, 25 to 50 millimeters; if it is sorghum, 19 to 25; if it is soybean, 25 to 50 millimeters; and if it is wheat, 25 to 50 millimeters. Now, let us see how to open a furrow. To open a furrow, we need a furrow opener. So, let us see what are the different types of furrow openers available. So, this is a shovel type. The left one is shovel type, and the right one is chisel type - chisel point type.

So, these are preferred in light to medium soils for medium to deep placement. That means, when the depth of placement is between 50 to 100 millimeters, these are the types of furrow openers which are to be used. Then, shoe type is suited for black cotton soil and when you want to put at shallow to medium depth, that is from 20 to 70 millimeters. In black cotton soil, then you prefer shoe type furrow opener. Then, the other one is full or curved runner type. So, runner openers were widely used with plate-type planters; they are still used on some precision planters. So, they will give a clear furrow. So, on that furrow, we can drop the seeds. Then you can have single-disk type furrow opener or double-disk type furrow opener. In the case of a single-disk type furrow opener, this is used in drier areas, and it permits good soil penetration and excellent trash clearance. So, if some trash is present, then a single-disk type furrow opener is suitable there.

A double-disk type furrow opener allows more uniform placement of seeds in soil that is properly cultivated. That means, when the seedbed is properly prepared and trash-free. So, when a seedbed is properly prepared, there is no trash present. So, it is trash-free. So, in that condition, we try to use the double-disk type furrow opener. The double-disk opener is now used on many precision planters, either alone or combined with a runner-type opener. So, to give a clear furrow, we have to go for the double-disk type, and the condition is that the seedbed has to be prepared very nicely; otherwise, this type of furrow opener is not suitable.

The seed metering has two aspects: the first aspect is the seed rate, which means you have to maintain the metering rate. The metering rate is important in any planter to ensure that the desired plant population is achieved, which is the requirement. Then, the other aspect is uniformity; when you put the seeds into the soil, they should be uniformly distributed; otherwise, the operation of subsequent machines will be difficult. So, to verify this one there are different tests available. The first test is your calibration of a seed drill. The

calibration is done for a seed drill to find out what is the seed rate it can handle. So, if a seed drill is about to handle 100 kg per hectare then actually it should handle 100 kg per hectare or plus or minus 10 per cent if you follow the BIS standard. So, how to verify that one that is important thing. So, that will give you whether the seed rate is achieved or not. Then second one is to verify the uniformity of seeding, the seed metering unit should be tested either in the laboratory or in the field by one of the following methods. One is your sticky belt method, the other one is sand bed method. So, let us now start with a calibration of a seed drill. Then the calibration of a seed drill the procedure which has to be followed is : first the entire unit that means, the entire seed drill has to be raised. So that the ground wheel is free to rotate. Since, ground wheel, we are taking power from ground wheel to the metering shaft where the metering units are mounted. So, ground wheels - if they are in touch with the ground then it is difficult to rotate. So, the first thing in calibration is : the seed drill has to be raised. So that the ground or the drive wheel is free you can easily rotate it. Then second is : the seeds are to be put into the hopper up to a certain level either to the one fourth or half or two third of the hopper capacity. Then, the lever for setting the seed rate has to be fixed. Suppose you want 100 kg per hectare; there is a lever where you can fix that as supplied by the manufacturer. Then, the trays are to be kept below each furrow opener or if you do not have a tray, what you do is remove the furrow opener, the seed tube from the furrow opener, and then put plastic bags at the end of the furrow opener. They are to be tied to collect the seeds that will be falling from the seed tube. Then, the ground wheel has to be rotated maybe 20 times or 30 times as needed at an uniform rate. Then, we have to collect the seeds, take the weight, and sum all the weights of the grains collected from different outlets. You have to take the weight, which will give you the total weight of seeds that have been dropped. So, if you denote it as W g, then the width of the seed drill has to be calculated. Now, how do you calculate it? Usually, the seed drill is specified by the number of furrow openers and the spacing between two adjacent furrow openers, similar to your cultivator. So, if it is a 9-row seed drill, that means nine is the number of rows through which seeds are dropped into the furrow, and the spacing between two adjacent furrows is 225 millimeters or 300 millimeters, depending on what we want to maintain. So, if you know the number of furrow openers and the spacing between two adjacent furrow openers, then you can calculate the width of coverage.

The next thing is how much distance you have traveled. So, the distance traveled, as I said, is 20 or 30 times you have to rotate the ground wheel. First, you have to measure the effective diameter of the ground wheel. Then, you can find out the peripheral distance in one revolution. Depending on the number of RPM, you can calculate what the total distance

traveled will be. Now, the distance traveled multiplied by the width will give you the area that is covered.

So, the distance traveled multiplied by the width will give you the area that is covered. So, we know the weight, and we have now calculated the area. So, weight divided by area will give you the seed rate, and that seed rate should match the seed rate mentioned by the manufacturer. So, this is how you have to do the calibration. Again, it is not only the seed rate, since you are carrying out calibration at different filling levels in the hopper.

So, someone can fill it up to one-fourth, someone can fill it up to half, and someone can fill it up to two-thirds. So, we have to carry it out at different filling levels. Follow the same procedure and then see whether you are getting the desired seed rate or not, because during operation, what happens is initially if you fill it up to, say, two-thirds, then slowly the seeds will be released through the furrow openers, and the seed level in the hopper will go down. So, if the one-fourth level does not give the same seed rate as the two-thirds level, then there is a problem. So, we have to calibrate the seed drill at different filling levels in the hopper where the seeds are stored and then find out whether the same setting gives this exact seed rate or not. So, we have to carry out this exercise two or three times for each hopper capacity - hopper capacity meaning the capacity to which the seeds are filled.

So, I will show you a video. This is a 9-row seed drill. So, I just wanted to show that there is seed flow. The calibration part you can see - I have put the trays here and below each furrow opener, and the entire unit has been raised so that you can easily put the seed trays. Once the seed trays are in place, you start rotating the ground wheel, and when the ground wheels rotate, the metering units will rotate. Then, seeds will flow through each seed tube and be collected in the tray. So, what I will do is take these samples independently, then take the weight from each furrow opener and sum those weights to find out the total weight.

So, as I said, there will be a variation in quantity dropped per hectare and quantity specified to be dropped per hectare. This is the parameter which has to be verified. Whatever has been recommended, what setting we have put, and what exactly we are getting - that variation should not be more than 7 percent for different furrow openers and different capacities of the hoppers. Different capacity means the seed level in the hoppers. The variation in dropping due to box filling at one-fourth, half, or two-thirds of the rated capacity shall not exceed 10 per cent.

These are specifications given by the BIS standard. So, you have to stick to this to ensure that the seed drill is working perfectly. Then comes the uniformity distribution. Here also,

you can measure - while carrying out calibration, the uniformity because you have collected the samples individually. You can do that exercise—that means, variation between different furrow openers. Whatever amount of seeds are collected at different furrow openers, whether there is some variation or not that you can verify.

So, what you have to do is take the independent weight that means, the weight of each tray - whatever seeds are available, then take the mean, and from the mean, you have to find out what is the variation, the percentage of variation. So, that variation of each furrow opener. So, in that case, the BIS standard has also given what should be the range of variation. If it is within that range, then you accept it; otherwise, you will not accept it. So, the other method of uniformity measurement is, as I said, the sticky belt method.

You can carry out in the laboratory that there is a sticky belt. Belt means a canvas belt which has to be smeared with grease and that belt has to be rotated. At the top of the belt you can see there is a metering mechanism, and that metering mechanism is to be operated by taking power from a DC motor and the belt speed will be simulating the speed of the seed drill in the field. That means, belt speed will be remaining same as that which the seed drill speed is maintained in the field. And then power is taken from the metering unit from the DC motor to the metering unit . Then since we have put grease on the belt, so, whatever seeds will be falling that will be sticking to that belt. So, these are suitable for measuring your hill droppings or single plants. If mass flow is there, you may not get accurate result.

So, once you get the seeds on the belt then you stop the belt and take measurements like what is the spacing between two adjacent seeds, how many seeds are dropped per dropping you can see, you can find out. So, all those things you can take it on the belt. So, that is an easiest method. The other possibility is: instead of using a sticky belt you can put a sheet of plastic sheet on the floor and then you apply a thick amount of grease. So, that the seeds after falling in the plastic sheet will not jump and then operate the seed drill over that plastic sheet.

So, you can see here the plastic sheet is there then over that the seed drill is there. Then you operate the seed drill at the same speed at which you want to operate in the field then you will get seeds in different rows. So, here this is a hill dropping type metering mechanism. So, you can see very well. So, this is the hills these are the hills and you can have say 4 rows here. So, in 4 rows you will have seeds hills of hill droppings. So, you can easily measure the distance between hill to hill and then count the number of seeds present

in each hill and then you can check whether they are uniform or not, whether they are uniformly put into the soil or not in different rows.

Then if it is a sand bed method you can directly take it to the field, what you have to do is the same procedure as I said for the plastic sheet. Only what you have to do is in place of plastic sheet we can put sand - moist sand. And over that bed moist - filled with moist sand you have to operate the seed drill at the same speed at which you are operating in the field. So, you will get the seeds falling on the moist sand. So, you can have a clear print, where the seeds are falling and then take the measurements, spacing between adjacent seeds, number of seeds dropped in each row then then you can compare with different rows. Those observations can be easily taken. So, whether you follow a plastic sheet method or whether you follow a sand bed method they are all the same. Then I will discuss some of the performance requirements which has been given by BIS.

The first requirement is the seed rate shall be easily adjustable up to 125 kg per hectare. That means, this is for wheat seed because wheat is 100 kg per hectare, the seed rate. If you are sowing it late then the seed rate has to be increased to 120 kg per hectare. That is why they have mentioned 125 kg per hectare. This is for exclusively for wheat seeds not for others. The percentage of visible damage to seeds should not be more than 0.5.

So, during operation since metering mechanism, the plates are rotating there is a possibility that the seeds may get damaged. So, we have to take care of those things so that means, the percent of damage should not be more than 0.5. Then the variation in dropping due to box filling, if the height of seeds present in the hopper varies then whether it is giving some different seed rate or it is maintained - the seed rate is maintained that has to verified and that the variation should not be more than 10 per cent. Then the variations in quantity of seed drop due to change in speeds shall not exceed 15 per cent So, seed rate should be independent, seed drill should sow seeds independent of the forward speed. So, whether you operate at 3 kilometer per hour or 4 kilometer per hour, the seed rate should not change. If seed rate changes means it is not acceptable and the maximum variation is 15 per cent. You cannot allow more than 15 per cent variation. Then the variations in quantity of seed per meter of row length shall not exceed by 10 per cent. In a particular row if you are getting 10 seeds per meter then that 10 seeds should be repeated not that 10 in 1 meter again 15 in another meter. So, if that variation is there then the variation should not be 10 per cent should not be more than 10 percent. Then variation in dropping seed in different feeding outlet. So, this one is for single row, this one is comparison between adjacent rows,

shall not be more than 7 per cent. So, variation between row 1 and row 2, row 2 and row 3, row 1 and row 3 that those variation should not be more than 7 per cent from the average.

Then, variations in quantity dropped per hectare and quantity specified to be dropped at a particular setting should not be more than 7 percent. This one, we have already tested in the calibration part for this variation. Then, other requirements like the drills should be able to sow seeds up to a depth of 100 millimeters, and the wheel skid is specified. Skid should not be more than 10 per cent. That means you do not allow the wheel, the ground wheel, to skid. If at all some skid is there, then the skid should be limited to 10 per cent.

Otherwise, what will happen is if the ground wheel skids, fewer seeds will drop into the field. So, your plant population will decrease. The drill shall be able to sow wheat and one or more of the following seeds. So, in order to make it a multi-crop seed drill, its working hours in a year will be increased. So, the cost of operation will decrease.

So, that is the reason why it is said it should be able to sow seeds other than wheat. So, other requirements are the tractor-drawn seed drill should have 5 to 15 furrow openers. Minimum is 5, maximum is 15. If you exceed beyond 15, there is a possibility of difficulty in turning. So, limit up to 15, minimum should be 5, so that at least it can cover the track width. Then, the row spacing should be adjustable because if you are making it a multi-crop, obviously, the row-to-row spacing will differ from crop to crop.

So, there should be an arrangement to make the row-to-row spacing adjustable. Then, the weight of the tractor-drawn seed drill should be within the limit of 18.5 kg per drawbar hp. If the tractor hp is fixed, then the weight of the tractor-drawn seed drill should be this much. They have specified this so that the tractor can easily handle it. So, these are some of the requirements. We will discuss in detail about the uniformity, how to calculate uniformity with some other parameters a little later.

Now, the broadcasting method. I will come to the broadcasting method. In broadcasting, what we do is we do not follow any rules; we simply distribute the seeds. Either with the help of a hand or with the help of a centrifugal broadcaster. So, I have shown this broadcaster. But again, when we broadcast the seeds, the main thing is whether it satisfies the seed rate,

and whether the broadcasted seeds are uniformly distributed over the field or not. These are the two factors which are to be assessed. So, for assessing these factors, what we do is we put a set of trays in a row, maybe 10. And then we try to carry out the seeding operations

either with the help of a centrifugal broadcaster, which is run by a machine, or by hand. And then, we ensure that the swath is already covered, swath means the distance where we put the first tray and the last tray, that is sufficiently covered during seed distribution.

Then, after operating this, we collect those trays - whatever grains are collected. The tray sizes are 15 centimeters by 15 centimeters or 10 centimeters by 10 centimeters. So, we collect those trays, and then we try to measure the weight of seeds present in those trays. Then, we try to find out the mean, the standard deviation, and the coefficient of variance. So, this is the formula which will be used: $\bar{q}$ (the mean) is the summation divided by the number of trays, and that will give the mean value.

Then, we try to find out the standard deviation utilizing this formula: standard deviation $sd = \left[\frac{\sum_{i=1}^{i=n}(q_i - \bar{q})2}{n-1}\right]^{0.5}$, where n is the number of trays, which are put in the swath, raised to the power of 0.5. So, the standard deviation will be calculated, then the coefficient of variance, which is nothing but (standard deviation/mean) × 100. So, here q_i is the quantity of seed in tray i (either mass or volume), the number of trays is denoted by n, $\bar{q}$ is the average amount in trays, Sd is the standard deviation, and CV is the coefficient of variation in percentage. Then, the simplest method of testing pattern uniformity is to drive the seeder across a lateral row of trays while the seeder is operating.

So, the CV value, when you calculate it, should ideally be 0, but we never get a value close to 0. So, it should be more than, say, 20 percent or 30 per cent, but it is still acceptable. But the condition is that CV should be low, so that we can ensure the seeds are uniformly distributed. So, this is the method which is followed for the broadcasting method to verify the uniformity in broadcasted seeds. So, whether it is seed or fertilizer, it does not matter, we follow the same method.

So, these are some of the methods we discussed, and these are the references. We discussed the theory of furrow opening, types of furrow openers, and how to calibrate a seed drill. We also covered the different methods to measure uniformity of distribution and how to measure it for a broadcasting method. These are some of the topics we discussed here.

Thank you.