Design of Farm Machinery

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Lecture 26 : Seed drill/planter

Hi everyone, this is Professor H. Raheman from IIT Kharagpur. I welcome you all to this SWAYAM NPTEL course on Design of Farm Machinery. Today is Lecture 26, where I will try to cover topics related to seeding equipment. The concepts which will be covered: types of seeding, functions of a seed drill or planter, then components of a seed drill or planter, then different types of metering units used in the seed drill or planter. Crop sowing - the basic thing is you should know why you go for sowing a crop and what operations are involved in sowing a crop.

So, crop sowing operations involve placing seeds or tubers - tubers in the case of potatoes - into the soil at a predetermined depth. Random scattering or dropping of seeds on the field surface, which is otherwise known as broadcasting, or setting of plants in the soil. So, since this is about seeding equipment, the setting of plants will not come into the picture; we will only discuss how seeds are placed in the soil. Now, the machines that place seeds in the soil and cover them in the same operation - those machines create definite rows and are called seed drills.

The machines that drop seeds in definite rows are called seed drills, and the figures of them are shown here. Like, on the left side, the red one is a seed drill, and on the right side is a seed drill in operation. It is mounted to the tractor's three-point linkage and then pulled by the tractor. With appropriate planting equipment, seeds may be distributed according to any of the following methods. Either by broadcasting, which is otherwise known as random scattering of seeds over the surface of the field.

Second one is drill seeding, random dropping of seeds and covering them in furrows to give definite rows. Here, seed to seed spacing is not there only to drop the seeds into a furrow and then the seeds are to be covered. In precision planting, the machines are used for accurate placing of single seeds, single seed that is important. Placing of single seeds

and at equal intervals these two parameters are important for a precision planting. And so, we will get row to row spacing as well as seed to seed spacing.

The fourth one is hill dropping that means, placing of group of seeds at about equal intervals. So, the difference is instead of a single seed we are dropping a group of seeds into the furrow at regular intervals. So, we will get row to row as well as hill to hill dropping. In case of broadcasting when we distribute the seeds over the soil surface, those seeds are to be covered otherwise the birds will be eating away those seeds. So, for covering we have to either run a plank or something so that the seeds will be immediately covered that has to be taken care of.

So, what are the functions of the seed driller or planter? The first function is: it should open the seed furrow to a proper depth. So, that seeds can be put into the furrow at that depth. The second one is metering of seed, you have to meter the seed. Then deposit of the seed depositing the seed in the furrow in an acceptable pattern. Then, covering the seed and compacting the soil around the seed to the proper degree enhances germination and emergence. So, these are the four tasks that must be performed by a seed drill or a planter. Now, let us see what components are available in a seed drill to perform these functions. The first component is the hopper, where the seeds are stored. The second component is the metering unit, the third is the seed tube, the fourth is the furrow opener, and the fifth is the furrow closer. So, the hopper stores the seeds. The metering unit carries the seeds from the hopper and drops them into the seed tube. Through the seed tube, the seeds are transferred to the furrow, which is made by the furrow opener. After the seeds are dropped, the furrows are closed with slight compaction to ensure proper germination. So, out of these components, the metering unit is called the heart of the seed drill or planter. Let us see what different types of metering units are available, and we will discuss these metering units or mechanisms briefly.

Seed metering has two aspects. The first is the metering rate, which refers to the number of seeds released from the hopper per unit of time. The metering rate is important in any planter or seed drill to ensure the desired plant population is achieved. Otherwise, if the seed rate is 100 kg per hectare and we drop only 80 kg per hectare, we will not achieve the expected yield during harvest. So, the seed rate must be maintained. Additionally, seeds must be singulated in precision planters. Singulation is not required for all types of seed drills and planters. Singulation is only required in planters, where we require these many number of seeds are to be dropped into the soil, where the dropping of seed is done by number not by mass. And this seeds are to be dropped at uniform spacing in each row. The

first one as I said the metering has to be done either by mass or by numbers. So, when it is by mass then there are different metering mechanisms available. The simplest one is the orifice type variable orifice type seed metering mechanism. As I said this is the oldest principle for metering seeds, is the simplest one there is no mechanism. There will be a storage device which is nothing, but this hopper and then the bottom of the hopper there is an opening and that opening has to be varied depending on the flow rate. So, you have to have a device to vary the opening size. So, that you can vary the mass of seed which is dropped. And to break the breeze because we are utilizing a trapezoidal step hopper. So, what will happen? So, each seed will have a tendency to go out. So, that means, there will be competition between seeds to go out from the hopper. So, there may be a bridging action by which what will happen the seeds will not go out. So, it will be blocked. To break that bridge, we have to provide an agitator. So, this agitator, which is provided, is nothing but a simple shaft provided with a curved plate. You can say that the plate has to be rotated inside the hopper. So, that it breaks the bridge for the free flow of seeds. So, as I said, the volumetric flow rate of seeds is regulated by changing the orifice size. So, at the bottom, there is a plate with different hole sizes. So, depending on the requirement, we can change the hole size. So, that will change the flow rate. This is the simplest one, and it is used for the mass flow of seeds. When you want the flow of seeds or the dropping of seeds to be by mass, not by number, then we follow this kind of metering in it.

The other most popular metering unit is the fluted roller metering unit. There is a fluted wheel. The fluted wheel assemblies are positioned at the bottom of the seed hopper, so that seeds can flow into the openings by gravity. So, the fluted wheel can be moved endwise, that means it can move laterally along the feeding shaft over which it is mounted, thereby the length of exposure is changed. So, if you want to change the flow rate, then we can change the length of exposure, that means this portion. So, this can be moved to increase flow. So, that once you increase the length the volume will change. So, depending on the requirement we have to adjust this one. The other possibility is we can rotate it at a higher speed. There are the two possibility one is by rotating the shaft at a higher rpm or by changing the length, but rotating the shaft at a higher rpm is not preferable because it may damage the seeds. So, that is why the most preferable one is by changing the length of flutes.

Then maximum flow rate occurs when the fluted wheel covers the entire width of the gate, while zero flow rate occurs when the non-rotating cutoff covers the full gate. If you cover this one then there will be no flow. Then the flow rate also varies with the rotational speed

as I already said. So, there are two possibilities. So, so we will prefer the first one that is changing the length by shifting the feeding shaft the fluted ah flutes in the feeding shaft.

Then these are the two metering mechanism which are used for metering mass of seeds not by number. Now, let us see when you want to meter seeds by number that means, single seeds then horizontal plate planter is another metering unit which can be utilized. In a horizontal seed plate planter, the periphery of the seed plate contains cells designed to accept single seeds and in the periphery there will be cells which will and this entire unit is mounted on the bottom of the hopper. So, hopper will store seeds and the seeds will occupy those spaces. Seeds enter the cells as the plate rotates in the bottom of the seed hopper. Then, any excess seeds are removed by a stationary cut off and as each cell passes over the seed tube, a spring loaded knockout forces the seed into the drop tube. So, you have to there is a positive discharge that means, the spring at the outlet will give a tapping force to the seed. So, that seed will not be missed it will be moving through the seed tube or the drop tube. Then there is a cut off device, the cut off device could be either a brush type or a spring loaded scraper which will remove the excess seeds. Then for uniformity of seed, it is necessary to ensure that only one seed will be fit into each cell that is important. So, what we have to do is seeds that are naturally non-uniform such as corn kernels they have to be graded into uniform size prior to planting. Otherwise you cannot utilize this kind of metering mechanism because the cell size is fixed. So, if the sizes of grains are not uniform then maybe in one cell more than one seed will be carried. So, that is the difficulty. A wide variety of replaceable seed plates are available to match the various sizes of and shapes of seeds that is another possibility.

So, if you want to make it multi-crop then you can have different sets of plates - seed plates. So, that it can accommodate different seeds. Same seed drill they cannot accommodate different seeds. Now, the other one is single metering unit that means, dropping single seeds is internal double run metering mechanism. The internal double run seed metering mechanism is used in some drills. As with the fluted wheel, the internal run is quasi positive displacement metering device, but the seed spaces are formed by fins on the inside of the wheel.

There are fins which will regulate the spacing between the seeds. It is called double run because the two wheels are positioned back to back that means, you have two sets of disks they are placed back to back, but you cannot utilize the two sets at a time you have to utilize only one set at a time. So, one has much smaller seed spaces and is used for small seeds the other one is used for large seeds which has large spaces. The internal double run units

they are positioned at the bottom of the seed hopper. So, that seed can flow to the cells, seed can flow from the metering unit by gravity.

Only one side of the internal double run is used at a time. As I said before a removable feed cover is used to block the other side. If you are not utilizing the other side then you block that side so, that only seeds will be available to one side. Then you can provide an adjustable feed gate that means, an adjustable feed gate is provided for each side of the unit. The distance between the gate edge and the internal fins can be regulated to control the feed rate. These are some of the things.

Then there is a vertical rotor with single cut off ejector. So, this is a single seed metering unit. The vertical rotor metering devices are often used for precision planting of vegetables and sugar beets. The concept is: the plate has cells on its periphery. So, that will carry- that has to be put in the bottom of the hopper. So, then plate has to be rotated and the seeds which are available or which are carried through the cells will be dropped one by one in the seed tube. Then there is inclined plate with cells that is another metering mechanism for single seed. This device has cups or cells around the periphery that has that pass through a seed reservoir fed under a baffle plate from the hopper, then it lifts the seeds to the top of the plate, then it drops those seeds into the delivery tube, then from the bottom it will carry and it will drop at the top. A stationary brush is usually used for positive unloading. So, the brush will try to remove the seeds so that the unloading part is positive that means, seeds will be dropped in the seed tube. And here, the seeds are handled in more gently than the horizontal plate in it because there is no cut off device. Then plates of different sizes, cell sizes are available for seeding different sizes of seeds. So, you can change the plate those plates that will accommodate other seeds.

Then another type metering mechanism is your cup feed metering unit. I have shown different views means different setups, but all are cup feed type. So, basically it is a spoon type thing which is a cup it has to accommodate a seed. The size of the cup should be such that it should accommodate the seed and again this has to be mounted inside the hopper. Then with the help of a rod we can say - if these cups are mounted to a plate with the help of a rod and when that plate is rotated, these cups will be engaged with the seed and they will carry the seed from the bottom and they will drop it on the top side. Seeds from these are all single seed, but they are not precise there may be some missings. So, if you want to have a precision planter, then precision dropping of single seeds, then this is a belt type precision seed metering unit. Seed from the hopper enters the chamber above the belt. So, you can see this is a belt. So, the seeds - this one is the hopper, from the hopper there is a

passage through which the seeds will be available to this belt. Though I have written above the belt through opening A, opening A is this one not this one and it is maintained at a control level. As the belt moves clockwise the counter rotating seed repeller, this one is the repeller one, the counter rotating repeller one will push the excess seeds back side, it will not allow the excess seeds. only the seeds which will occupy the holes present in the belt that will be released because of this pressure exerted by the repeller. There is a plastic unit here. So, the moment, belt comes at this point, the repeller will give a kind of force to the seeds so that the seeds will be released. And the belt is driven by the ground wheel taking power from the ground wheel. So, lack of a positive unloading device because it is the only repeller which gives a tapping force to release the seed. So, the positive unloading device is not there. So, there may be a variation or there may be some missing of seeds, otherwise it is a suitable arrangement for precise dropping of single seeds.

The other precision planters are air planters. The air planter has a ground-driven seed drum. This is the seed drum, which is driven by the ground wheel and pressurized to about 4 kilopascals by a PTO-driven fan. The maximum practical drum speed is approximately 35 revolutions per minute. Then, seeds flow by gravity from a central hopper to maintain a shallow reservoir of seed in the bottom of the drum. Each drum can be designed to serve 4, 6, or up to 8 rows, depending on the number of holes in a row. Then, each hole terminates in a seed pocket at the inner face of the drum. As the drum rotates, air will escape through the holes, and when seeds enter the seed pocket, the differential pressure will hold each seed in its pocket until the drum rotation brings the seed closer to the seed tube. So, when a seed tube is present, the seed will be forced into the seed tube because of the pressure created inside the drum by the fan. So, the seed will flow, and the air will also push the seed through the seed tube, which is an advantage. So, a row of external wheels near the seed tubes blocks the hole momentarily. Thus, removing the differential pressure and allowing the seed to fall into the seed tube. So, air escaping through the seed tube will carry the seeds into the planting units and deposit them in the rows or furrows. Crops that can be planted with the air planter include beans, corn, delinted cotton seeds, and sorghum. These are some of the seeds that can be handled by air planting.

The seed drums are easily replaceable and you can change the seed drums depending on what type of seeds you are going to handle because the whole sizes are to be changed. And the main advantage of the air planter is that it has only one seed hopper to be refilled, thus permitting faster refilling that means, your field efficiency will increase. Then another precision planter is your pressure disk planter. So, pressure disk planter the is similar to

your air planter in that what is in air planter a positive pressure in the seed reservoir is used to hold the seeds in the pockets of the rotating seed plate. So, here the positive pressure is created to hold the seeds in the pockets. These pockets are nothing, but holes on the seed plate rotating seed plate. Unlike the air planter the pressure disk planter has a separate seed reservoir. So, it has a separate seed reservoir and plate for each row, there only one drum that will cover 2, 4, 6 or 8 rows, but here each row has to be provided with one such unit pressure disk planter. The gravity moves the seeds from the hopper to the metering unit. That means, the metering unit where it is fitted, the seeds should be available and at the metering unit a differential pressure holds a seed in each cell, cell means the holes on the seed plate. As each cell nears the drop tube, a soft brush cuts off the air supply to the cell and the seed falls into the seed tube by gravity. Unlike the air planter the seed tubes are not a conduit for escaping air. So, here the air is not allowed to enter into the seed tube as it is all precision metering unit the seed plate must be ground driven. It is obvious thing that the plate has to be driven by taking power from the ground wheel. So, that it can maintain row to row spacing sorry plant to plant spacing or the seed to seed placing.

Then, seed disks are replaceable, and disks are available for different crop seeds like corn, soybeans, edible beans, delinted cotton, pelleted or segmented sugar beet seeds, sunflower, sorghum, etcetera. So, depending on the size of the seed, you have to select the disc with holes that match the selected seeds. Then, vacuum disk metering of seeds is similar to a pressure disk planter. It is similar to a pressure disk metering unit, except that the pressure differential is supplied by creating a vacuum. There, we are creating a positive pressure; here, we are creating a vacuum on the side of the seed disk opposite to the seeds.

So, you will create a vacuum on the side of the seed disk opposite to the seeds. Seeds are supposed—there is a disk here. One side has the seeds available; the other side, you are creating the vacuum. Then, the plate will have holes, and because of the vacuum, the seeds will occupy those holes in the plate. Seeds from the hopper enter the seed reservoir, where vacuum created by a pump holds the seeds in the seed cells on the rotating seed disk. Then, the vacuum is blocked, or the cells reach a point above the seed tube. So, you have to block the vacuum. So, thereby, the seed will fall into the tube by gravity. A vacuum of 15 kilopascals was used for holding seeds in a vacuum disk planter designed by Giannini. This is one observation I am giving. Then, in commercially available vacuum disk planters, seed disks are available for metering edible beans, soybeans, corn, delinted cotton, and seeds like edible peas, peanuts, sorghum, and sugar varieties of seeds can be handled. The only thing is the seed plate has to match the seed size.

The seed plate has to match means - the whole size present in the seed plate has to match the whole size. So, selection of sowing and planting machines, it is essential to select the machine with a metering unit and furrow opener suitable for the crop and soil conditions. For small seeds, mustard and rapeseed, you can have vertical roller with cells, inclined seed plate with cells or smaller grooved fluted roller metering system. These are some of the metering devices which are recommended for small seeds. for medium seeds like wheat, soybeans, safflower and linseed ah we can have standard fluted rollers.

And for bold seeds such as groundnut and caster, we can have inclined cell plate or cup feed type metering system. So, these are for the seed drill where we do not require precision because this fluted roller or the standard fluted roller inclined cell plate or vertical roller itself these are not very precise metering units. So, if you do not want precise precise metering unit then you can go for this kind of arrangement. Else if you want precise dropping of seeds then you have to either take a precision seed drill such as belt type metering unit or you can go for vacuum metering unit or you can go for pressure disk type metering unit. So, these are some of the metering units. As the metering is the heart of the seed drill, so, I have given some idea or brief review about the different metering units available that will be helpful for you to select while designing a seed drill.

These are some of the references and in brief I can say types of seeding, components of seed drill or planter, then performance requirement of a seed drill and different types of metering units are discussed.

Thank you.