

**Farm Machinery**  
**Prof. V. K. Tewari**  
**Department of Agricultural and Food Engineering**  
**Indian Institute of Technology, Kharagpur**

**Lecture - 02**

**Ploughing and first opening of the soil , the design and component details**

Well, in my second lecture here I would like to tell you that Ploughing and first opening of the soil, the design and component and other component details. Well in the previous lecture, I have explained you that different implements and equipment are required. Now, here I will let you know as to what are the different equipment which are required for different operations, particularly with respect to tillage we will talk of because first is a requirement of opening of the soil and then, preparation of the seedbed. So, we will talk of those equipment now.

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### *What is tillage?*

Tillage is the mechanical manipulation of the soil for proper seedbed preparation in crop production.

Objectives of tillage:

- Develop a desirable soil structure for a seedbed or a rootbed.
- Control weeds or to remove unwanted crop plants.
- Manage plant residues.
- Minimize soil erosion by following such as contour tillage, listing and proper placement of trash.
- Incorporate and mix fertilizers, pesticides or soil amendments into the soil.

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FORMER HEAD | DEPARTMENT OF AGRICULTURAL & FOOD ENGINEERING

So, what is tillage? It is very important to understand what tillage is. A tillage is the mechanical manipulation of the soil for proper seedbed preparation in crop production. Why we need because, if you open the soil immediately, the soil bigger clots will open. Now, if you sow the seeds on that, these heavier clots will simply dump the small seeds and they will not allow it to open. So, we would like that there should be a very freeable and a smooth soil and seedbed preparation for the seed to grow, but need to it must have an environment which we call as while till, so that small particles of soil need to be

prepared from the beginning and for doing that, we will have to apply the different implements.

Now, the objective of this tillage is to develop a desirable soil structure for a seedbed root or rootbed; whether it is a seed to be put or for a root crop to be sown, control weeds or to remove unwanted crops. Yes if we do this operation, definitely you can control the weeds because although we do not sow the weeds, but the weeds grow on their own and that is why if we have a proper field preparation, the seeds will grow, but not the weeds.

Manage plant residues. Yes there could be plants residues, there could be a crop, previous crop and when we are taking the field operation, first ploughing of the operation or preparing the field, there could be some of the residues there. Now, we would also like to manage those residues and conserve the moisture for the second crop. So, this is another requirement of that.

Minimizing soil erosion by contour tillage, listing and proper placement of trashes; Now, this also helps us. Erosion of the soil or soil conservation is important here. when we are operation these equipment, particularly depending upon which type of equipment and for what operation we want and definitely this also many a times we would like to mix the fertilizers and amend the soil sometimes by using salt etcetera which mixed with this soil, so that the condition of the seedbed is better prepared. It depends on the condition of the soil initially and what we want to do the operation. So, for various these operations, we require a tillage equipment. Now, what are the equipments?

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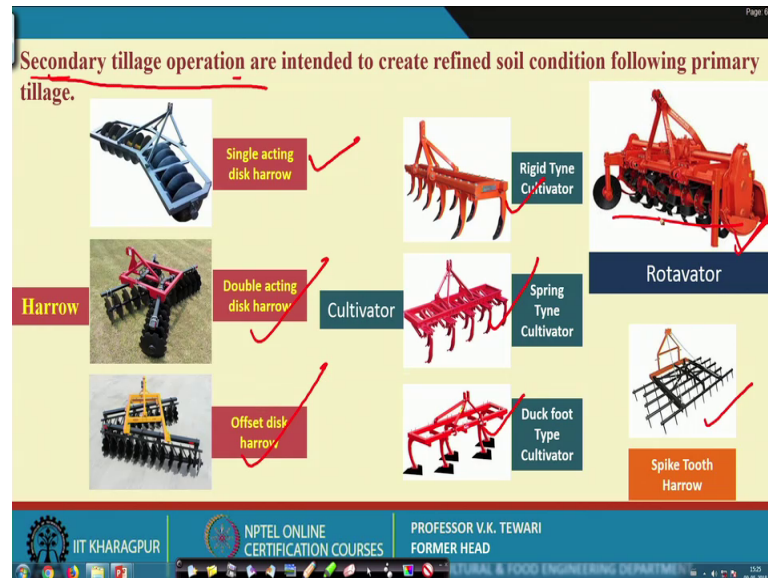
See the types of tillage equipments. Now, you will see that for tillage we need mainly two types of equipments. First is the primary tillage operation where we require primary tillage, primary tillage implements; Now, a mold board plough, a reversible plough, a disk plough, a chisel plough or a sub soiler.

Now, these are required in different conditions. For example, this mold board plough will be required for first opening of the land. This plough is also for first opening, but there is a difference between these two. What happens is that in mold board plough, you require that the field should not have the stony field or lot of bushes and trunks etcetera of the trough is etcetera. But, if there are bushes and stones etcetera at that location, this plough is the one which is best because it has disk and these disk rotates. So, they will not be able to get damaged as compared to the disk plough. So, these are the two which are there.

Sometimes when we want that a chisel plough or a sub soiler where in the lower part of the plant zone, plant root zone, we find that is hard pan comes and then, in order to cut that we require sub soilers. These go up to about 1 to 1.5 meters or so. So, these soils are, this sub soiler is required for that and this is another equipment. Although this is old equipment, this has become off late it has become very useful because it helps us in conserving the time at the head lands. So, management of the time at the head lands is

very important in this. This implement is used. So, we can say that these are normally designed to reduce soil strength, our plant residue and rearrange aggregates.

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Now, we go to the next set of machines where which these are known as secondary tillage operations. Secondary tillage, that means primary tillage. When we have opened the soil or just opened the soil, we will have bigger clots as I said earlier. Now, we would like to create as I said a continued atmosphere for this seeds to grow and for that we will have to have a smaller particles and that is only possible if the bigger plots are broken down into smaller and for that we have secondary tillage operation equipment.

Now, these are a large number say single active disk harrow, then a double acting disk harrow, offset disk harrow. Similarly, cultivators now, we can see a rigid tyne cultivator, a spring tyne cultivator and duck foot type cultivator. Then, there is another one which has become very popular nowadays is a rotavator, then a spike tooth harrow.

Spike tooth harrow is not that much, but yes this rotavator has become very popular and in fact, this is also operated by the tractor. We see that the PTO gets the maximum power out of the three power outlets of tractor, but it is the list used one and we have the other implements. The secondary tillage implements or the primary tillage implements, those are whole attached to the drawer or the three point linkage.



Although they are mostly used, they are the least effective ones. This is the nomenclature which we give that we have three power outlets of PTO, the drawer which is three point linkage and then, the third outlet is the hydraulic system which is used for lifting and lower of the equipment and maintaining a certain depth of the soil with respect to the tractor. So, these are the different operations. You can see that; the operation of single acting disk harrow, then the double acting disk harrow. The soil will be thrown in one direction. In the double acting, you will have two rows of the disk which are maintained and the after disk harrow; it is offset with the line of operation of the tractor here.

The spring tyne one's cultivator, these cultivators generally these are all operated within a zone of about 4 to 6 inches or may be about 8 to 10 centimeters. So, this is the operation which, this is the depth at which these are operated.

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### Other methods of tillage

**Minimum tillage:**  
Minimum tillage system as a means of reducing row crop production costs and improving soil condition.

Objectives of minimum tillage:

- ❖ Reduce mechanical-energy and labor requirements.
- ❖ Conserve moisture and reduce soil erosion.
- ❖ Optimize the soil condition for each type of area within a field.
- ❖ Minimize the number of trips over a field.

**Stubble-Mulch tillage:**  
The chief objective of the stubble mulch tillage is to reduce the wind and water erosion and to conserve water by reducing runoff. Stubble mulch tillage involves cutting the roots of weeds and other plants and leaving the crop residues on the surface or mixed into the top few centimeter of soil.


Zero till seed drill




Happy seeder




Mulch Machine





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Minimum tillage now as there is another concept which is not new one, which is for a long time is the minimum tillage operation, where the tillage we do not disturb the crop to a greater extent, but then these improve the soil condition and improve the soil moisture and where we do not have. Ok alright, so the minimum tillage here, minimum tillage here minimum tillage here.

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It means reducing the row crop production cost by improving this soil conditions. Here minimum tillage we will not be churning the soil to a greater extent and that we will save energy at the same time. The moisture content will be there, some of the equipment to reduce the mechanical energy here, conserve moisture, optimize the soil condition and minimize the number of trips over the field and hence, time for this we have a very popular equipment which is being used all over the country is a zero till drill. This another one which is happy seeder developed in Ludhiana and being used all over the country. This is one of the very effective tools for this.

Now, another thing for maintaining the soil moisture, we would like to after the soil has after the field, after the crop has been harvested, we would like to take advantage of the moisture which is there. And for that we would have, we would like that the same stubbles could be cut and then, left in the field, so that they will conserve the soil moisture and then, the next crop can be grown. So, for that stubble mulch tillage equipment, sometimes are used. One is shown over here as a mulch machine.

With this now, I would like that let us go to the field and have a look at the operation of these machines under the field conditions and I hope that you will enjoy this operation and have a look at the different operations. And we look forward to your questions and queries that you may have.

Thank you.

Dear students, welcome to the course on Farm Machinery. Well, when we talk of farm machinery, we must talk of the power source which will be driving those machines which are there for different operations in the field. Well, tractor has been found to be the biggest and the largest power on the farm and you must have seen in the tractor today which is available in a very different shape, but I am going to show you a tractor which was here in IIT Kharagpur and was operated during early 60s and 70s which has some features which were totally different then what it was at that time. Now, it is essential only to see that what was there in the history and what were the designs as at those times.

Now, you might have seen the tractor which is well balanced today and which has three point linkage, but a tractor which we have here which is a Russian tractor and it has two points, now these you can have a look at this. This is one point and this is two points, this is two points, the third point is not available here.

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So, the implements, generally the implements were larger implements and they were semi mounted type of implements because the third point if it is there, then it becomes a mounted implement and if the two points, it becomes certain portion of the weight is supported by the tractor and the other port is weight is supported on the road.

Now, another thing is that in this tractor we have seen that the distribution of the engine, the transmission, the differential and the final drive are totally well distributed, but in

case of this tractor we can have a look at this. You see that here, yeah you have seen in the present tractors, the PTO is a back PTO.

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Here, it is a front PTO. Have a look at this same six s plank, but this front PTO and the weight distribution, you can see here that this is a long beamed where the weights are kept and the balance of the weight with respect to the rear weight by giving weights on these.

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The steering balls; operated through this is a similar kind of operating system of the steering which are here the way we have Ackerman type of a steering system.

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If the weight of other portions of the engine transmission, everything is to be just here where the operator seat is there and you can imagine that what was the condition of the operation when the engine is vibrating here and the sound is being made, everything the fuel tank, everything was here and the tractor is operating and this tractor had all the controls are over here. So, no consideration you know even for the human being. So, it is



worth showing that this particular tractor which was totally different, then what it is at present and it has front PTO, it has back PTO, you have a two point linkage and all the subsystems of the tractor are concentrated at the back and above which the tractor operator use to sit. Now, when you go to a new tractor, have a look at that.

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So, you have a look at the new tractor. Today we have two points as I showed you there. Now, here there are three point linkage and this is the three first point which is a lower link. Then, this is another lower link, the second point and the third one is the stop linkage which is stop point. So, these are the three point which are there for attaching the modern implements in those modern tractors and the PTO is here which is a back PTO. Now, it has also a single link where you can sow the, attach the trailer where this is the pin here and we can attach at these three locations. Now, you see the weight distribution of the present tractor.

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We can see here, right from here is our radiator and then, the engine, the transmission, then differential and final drive.

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All these are well distributed, its say four wheeled drive tractor. Generally when we have a four wheeled drive tractor, we will have the weight distribution approximately on the front axle and rear axle, approximately 50-50. But when we have a two wheeled drive as we have in other tractors, we have about 65 to 70 percent of the weight on the rear axle and about 30-35 percent weight on the front axle, but this is a four wheeled drive tractor.

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Now, when we go to the earlier one, we can have a look at this point which was shown you earlier. I can have a look at this again that this is the lower links. It has only lower links.

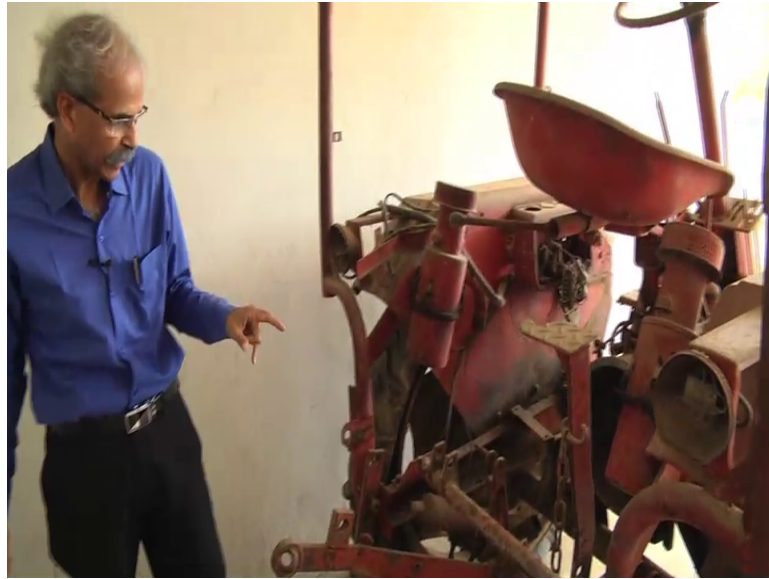
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This is the one link which has the point here, this another link which has the point here. Here there is no top link.



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The PTO, the back PTO is over here just like ours, but all the locations of everything was at this position. You can see the exhaust of the other tractor and exhaust over here. Now, the exhausts are located over here in contrast to the new tractors. The difference here is that these tractors we were not taught of particularly with respect to the operator because these were made well in 1940's or so and this is a Russian tractor.

In the 1960's only when John Deere had thought of about the tractor operators, then we had modern tractor seats just like have a look at this, a tractor seat which has suspension system and which is well balanced, even the controls. We had seen the controls that all controls were at one location, but here the controls are well distributed on the right hand side, left hand side and the leg controls the safety which is there. In fact, you can see the foot rest. The safety is very important here because when the person operates, now how to get in to the tractor and get out of the tractor, these are very important. So, with respect to that we can see that for person to get up, this is the location where he can have a look, he can hold here and then, put his leg over here.

In fact, sometimes you need for the smaller operator; you need another step here by which he can get into tractor. So, if you see the old tractors and the modern tractors, there is a large difference which has taken place over the years. Now, when we are talking of taking the power out of these tractors, we have three main power outlets. One is PTO which is in fact of two types. Generally PTO, we will have 6 splines or 21 splines. These

are for 540 plus minus 10 rpm and then, another 21 splines will have about 1000 plus minus 20. Now, when we want to take the power out of this tractor, the outlet as I said PTO which gives us about 90 percent of the power and then, when we go to the next power outlet, out of the tractor is the drawbar and this three point linkage is known as the drawbar that has lower links and the top links. So, we have to attach the implements on these three points as well as the single point at which we attach the implements which are draw type just like our trailer or any other implement.

Now, when you attach the implement or any equipment for taking power from PTO, you get about 90 percent of the power. When you attach to these three point linkages, then that implement although it becomes a mounted implement where in the total weight of the tractor, weight of the implement is attached to is virtually taken by the tractor and it also helps in the traction and the tractability of the tractor, but then trailed implements which are very less in number nowadays, we have all the most of the weight which is supported on the ground and a portion of the weight is separated here which are known as semi mounted type of implements.

Now, in later course of this course, we will let you know as to how they are attached to the tractor and what are the lines of force which are acting between the different points and how the implement is interacting with the soil; Now, here I will like to show you how the implements are attached with the three point linkages. Another thing which I wanted to show you where many times the students are not aware. Now, the tractor wheel, the tractor wheel what the size of the tractor wheel. Many times it is asked that: what do you mean by the size of a particular wheel?

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Now, see here it is 16.9 into 28. Now, this 16.9 into 28, this means that 16.9 is the section width which we can call from here or even we can take if draw a scale from here and then, this width is 16.9 which is in inches. Mind you this is very important to be noted that this is in inches, then 28, these also in inches and this talks of the rim width from here to here.

Central distance of this particular circle that is in rim width of the tire, these what are the important points because the students now we are all aware of M care system and this is still written in the PA system, where we have 16.9, the section width or the depth here in inches and 28 inches is a rim width. Now, if you want to get the diameter of the wheel you can have this 28 which is this to this and then, 16.9 which is generally this width, we take as this to this here and same thing on these sides.

So, you can add 16.9 plus 28 that is 16.9 plus 28 plus again 16.9. This way you can convert this into meters and you can get the diameter of the wheel. This is very important. Sometimes even the boys would not like to, would not be knowing as to what is meant by wheel base. We generally think that wheel base is the total length of the tractor which is not. So, in fact wheel base is the center to center between here from here.

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If you call this is the center to center distance between the front wheel and the rear wheel, so this distance is known as the wheelbase and wheel trait. This another thing which is important so far as the tractor is concerned is the wheel trait. Now, wheel trait is the center line. This is a center to center distance between the two rear wheels as well as the front wheels center to center distance.

This is wheel trait, this is called wheel trait which I showed there center to center distance between the two wheels is the wheelbase. This is important to know because when we want to find out the weight of the tractor and this calculation of the CG as well as the force employed by the tractor on to the implement, when it is operating in the soil, it is very important to know these parameters which are very essential portion in finding out the total draft requirement and hence, the power requirement.

We have a problem of having the total power and the matching of the implement because tractors depending on the type of the three point linkage we have. In fact, the three point linkage are having in different categories, the category 1 category 2 and category which go more mostly dependent on the power of the tractor. Generally higher horse power tractors ground, the category 3 and we do have about the category 2 which is most of the time within the 50 horse power tractor that we are using now. It is important that how much power we are taking from this tractor and how much power is actually required by the implement is still mystery because when you go to the soil, soil is a viscoelastic

medium that keeps on varying depending upon the soil moisture content and depending on the depth which is operated and depending upon the type of the soil it is.

So, this is a complex thing which needs to be found out and still people are working on the matching of the implements with respect to the power source which is still when we deal with in the treatment of mathematical treatment. I will show you how we are in a position to find out the matching implements for a particular power source. Now, we will show you how this is attached to a tractor. Many a times the actual attachment of the implement to the tractor is not but; let us have a look at this.

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Generally the first two links are attached first, the lower link and then, the top link. The problem is these only. We generally put the right hand side one and then, go to the left hand side and later on once these two are met, the top link is easier to be fixed into this. Now, it is locked by the pins which are given over here and slightly tightening of the top link, ok. The implement is now attached and now, it can be lifted or lowered depending on the situation. Yeah we can see that a two bottom mold board plough has been attached to a tractor. Now, it is very important to understand how the mold board plough acts, what are the different components of this.

In fact, the cutting edge or the cutting part of this mold board plough is this part. Now, this is the shear and this is the shear point. It has a mold board. Now, this boards purpose is to invert the soil. Now, it has the length. This is the shear which is there and in order to



connect this umm cutting edge as well as the board and the shear, this we have a frog which is known as this portion which is known as the frog of the component.

Now, the rear one has an additional attachment which is helpful in maintaining a clear furrow and that is the land side. This is called the land side of the mold board plough. If you take the center of resistance, the center of resistance will fall in between this line somewhere here. This will fall in between somewhere here when we consider the forces application and when we find out the total power requirement. We will deal with the analytical treatment in a later lecture. Now, this is connected and we will see a short demonstration of this.

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Continuation of what I said earlier, the mold board plough and the disk plough, these are the two primary implements which are used for opening of the soil. When the mold board plough is generally used for first opening of the soil where the land is not that stony or very grassy, but when it is very stony land, there the mold boards are not used. Generally we use these disk ploughs.

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Now, these ploughs in fact if you see the difference between those, the mold board ploughs and this is that this miniature plough which is generally in front of the mold

board plough is replaced by what we have is till up the mold board. We have a concave disk, steel disk of about varying between 600 tons to about 700 tones diameter of the disk of both these disks and generally it maintains a certain position with respect to the vertical. The disk there is one of this angle is known as the tilt angle.

Now, this helps in increasing the depth or maintaining a particular depth which we want. So, we can change this and the disk angle is now this is the direction of travel with the direction of travel.

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If you take the disk, this is the angle which we maintain is the disk angle which is here. Now, this disk angle and umm tilt angle, both angles are very important. The tilt angle generally varies between about 15 to 25 degrees or so and the disk angle varies between 42 to 45 degrees with respect to the line of travel. These are very important when we want the total output of these disks.

So, why it is important is in case of the stony ground, this disk rotates. So, since this rotates, there is no problem in operation of this, but had it been mold board plough, the plough will actually break if the ground is very stony. That is why for primary tillage, these two implements. The mold board plough and the disk plough are used for first ploughing of the field. Now, we will see the operation of this. It is lifted by the hydraulic system of the tractor as I told earlier and it will be maintained. Its position will also be



maintained with respect to the tractor with the hydraulic system. So, we will see the operation of this as well.

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As you can see that the disk has thrown, it scooped the soil onto one side from here, you can see this and the next one which will come here, again it will put on the same scoop soil. So, this is the way it throws the soil here. The inversion is not to the extent that you get there, but only because of the disk this implement.

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Although it is not set to be new, but this has started gaining lot of importance, reversible plough particularly because of time saving. We know that saving in time is going to see power and then, also maximizing the output of the plough. Here at headlines we do not have to run the tractor. Again it can be it seeks time in turning and you will not find any furrow which is an open furrow as you will see the operation of this and while it is lifted, the furrow is turned and the shift time in turning.

So, this type of system is very much gaining importance nowadays particularly because of its efficiency in saving time. No furrow opens I mean no open furrows and saving unnecessary running around the headlines. So, we will have the operation. Look at the operation of this particular equipment which is reversible plough, reversible mold board plough.

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As we have seen the operation of this equipment, apart from the primary equipment which are the mold board plough and the disk plough, we have secondary tillage implements. That means, after first opening of the soil we would like to prepare the soil prepare a soil tilt which is required for preparation and seeding of the seeds in any crops. So, the secondary tillage of this so, these are known as secondary tillage operations. This is one of these which is a disk harrow.

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You can see that there are two gangs of disk on the same axle here. One are notched gang disks; the other notch not smooth disks are there and they are set at certain angle with respect to the line of motion. Now, these angles are very important so far as the cutting width, cutting of the soil is concerned. The notch disk helps in if there is a grassy field or the grasses etcetera are there. It will cut those and these will smoothly take the soil and put it on to the other side. As we have seen the angle etcetera are changed by this particular lever here and this is one which is mostly used in preparation of the field.

Another equipment which we will show the operation slightly later is a cultivator. So, apart from the primary, the secondary implements which are used or the single acting disk harrows or double acting disk harrows or the tandem disk harrows and those of course, we have only shown the operation of disk harrow which is similar in action. Only thing we will find the single action, the soil is being thrown on one side only and in double action you will see the soil is being thrown on the opposite sides in the same width which is considered. So, we will see the operation once again.

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We have seen that two types of implements, particularly the primary tillage implements which are mold board plough and disk plough, there we had seen that the soil, a bigger clots are coming out. Now, when we operate the secondary tillage implement, the aim is that these clots will be smaller and the soil will become very friable. So, you can see that the soil become friable as case of say the big clots which are coming. So, the aim is to

prepare the soil in such a way that we have a very friable soil and then, the size of the clots etcetera very small and it will help in germination of the seeds.

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Now, this is another equipment which is operated by PTO. We can see that the operation of the PTO through the PTO.

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It is operated, they reverse to joint here. Current there is a warn gear and this particular equipment is a rotavator and this has become very popular nowadays because it saves time and energy because earlier we have to have a primary tillage implement, then

secondary tillage implements and twice or thrice operation of these and so, energy requirement is very high to prepare the soil before seeding. Now, this has become very popular nowadays because it does not require several operations and several passes. In fact, after harvesting of the crop, you can operate this and then prepare the field for sowing so many locating. We are operating this equipment and particularly where the soil is not very hard, this is one which is very popular, saves energy and all advantages with this. So, this is another equipment operated by PTO.

As I said that PTO is the one which has the maximum power outlet, but a maximum percentage of power outlet, but it is least used, but this equipment has made it to be used to a greater extent. We will see the operation of this rotavator in the field now.

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Yeah, we can see the operation of this particular equipment. Let us see. You do not need any other thing and simply the seedling can be operated and seed can be sown. So, that is the importance of this particular equipment which has gained over last 10 years or so very much popular and being out by, preferred by the farmers in a greater way, ok.

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This is another equipment which is secondary tillage equipment. It is a nine end cultivator. You can see that the four tensor in the front, this four tensor are in the front and the five tensor in the back.



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This is the shovel; this is which is called a reversible shovel. Now, there are others which are spring connected, this rigid one and job of this is to break the clots which have been prepared by the mold board plough or the disk plough. Now, the operation of this plough actually preparation of the field will be at least twice operation of this. This will be required for preparing the field as you have seen in the case of a rotavator.

So, definitely it requires more energy as compared to that, but then in conditions where we have to prepare the field after first ploughing and second ploughing which has been a virgin for a long time, then you will require the operation of this. We will see the operation of this as it is mounted and connected to the tractor.



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Now, definitely this particular implement has broken the soils and the big clots, but then you can see yourself that it will definitely require at least twice operation of this and then, at least a planking of this. That means, smoothening of the soil, then only the field will be ready for seeding. But then this has a separate requirement when the field is virgin and it has been operated by other mold board plough or a disk plough where the soil has been inverted and then, it needs to be broken into smaller particles and that is why you require this particular equipment.