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**Lecture - 07**
**Tractor implement hitching system**

Well, dear students, you have seen the various aspects of implements being connected to Tractor and how they operate in the field. And, what are the different design factors, which are considered if you want to have a certain matching implement to a power source.

The last lecture we had talked about the PTO Driven Tractor Rotavator. And, we had considered all the factors and we saw how they an efficient design of a rotavator can be performed. Now, in this series of lecture my 7th lecture here talks of tractor implement hitching systems, well you might have seen how to hitch an implement in the field, which was described earlier.

Now, we will talk of certain other aspects, which are very important from academic point of view and from the point of view of the researchers and the designer's right let us go to the slides.

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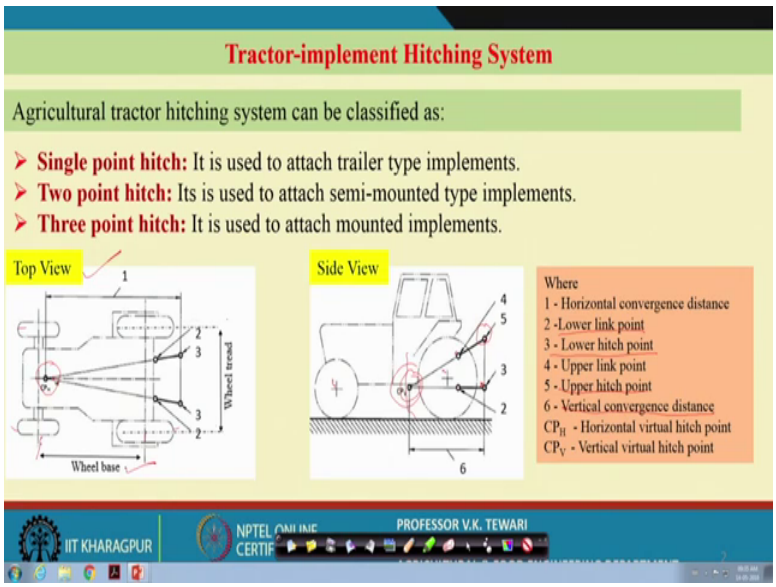

Now, in this slide I have shown the different hitching points, well you may remember that we have already discussed in my previous lectures, that the 3 locations where the drawbar is connected with of the tractor single point, two point and three point.

Well we had discussed earlier that two point hitches are generally for larger equipment and they are not involved in the Indian conditions, we do have the single point and the three point. So, we will discuss about the single point and three point in later course of the slides here, but let us look at some of the important features of the tractor implement combination.

For example, have a look at this. Here, this is the top view of the tractor here. In this case, we can very easily see what are the details. I have already explained these details in previous course, but it is very imperative to have a look at those parameters again, for better understanding and have a correlation between what has happened earlier and what is now?. So, you can see that the wheelbase, wheelbase is the centre line between distance between the center line of the front and the rear this is the field base here.

Similarly, the wheal tread I discussed that wheal tread is a stronger bearing on the rotor row spacing, which when we want to change. Although, this is provided in by the tractor manufacturers, but farmers because of various reasons, particularly the difficulty in changing this they do not change that and use. This is the distance between the center line of the rear wheels here and maybe same case in case of the front as well.

See if you see the side view of this. How the hitches are kept? Now, in this side view of this you can see that this is the front axle, this is the rear axle, then the lower links, you can see that these are the lower links, these hitch point, this is called the hitch point, this is the lower link hitch whose hitch point is this, then this is the lower link point again of the other (Refer Time: 03:53) point, then 5th this is the upper hitch point, this is the upper hitch point where and upper link is this.

So, upper link is this here I linked at this position and this is the hitch point, this is the linked at this position this is the hitch point, upon the there are 2 lower links here. The distance 6 is the vertical convergence distance. Now, this vertical convergence distance is between the C P V virtual hitch point and the horizontal virtual hitch point now here.

The virtual hitch point if you recall I had discussed earlier, that you will get a virtual hitch point, when you extend the top link backward and the lower link backward, you will get a virtual hitch point. Of course, when I can implement is connected to this, then this will keep on changing the location of this will keep on changing , but then to understand this is the point, where which is the virtual hitch point, when you extend the the top link and the lower links here.

The horizontal hitch point of course, if C P H is the Horizontal hitch point which is shown in this diagram here. These horizontal hitch point at this position, because when you see in the top view this is the location which will be seen here. So, we will talk of the single point hitch, now what is single point hitch and, how the different implements are connected to this.

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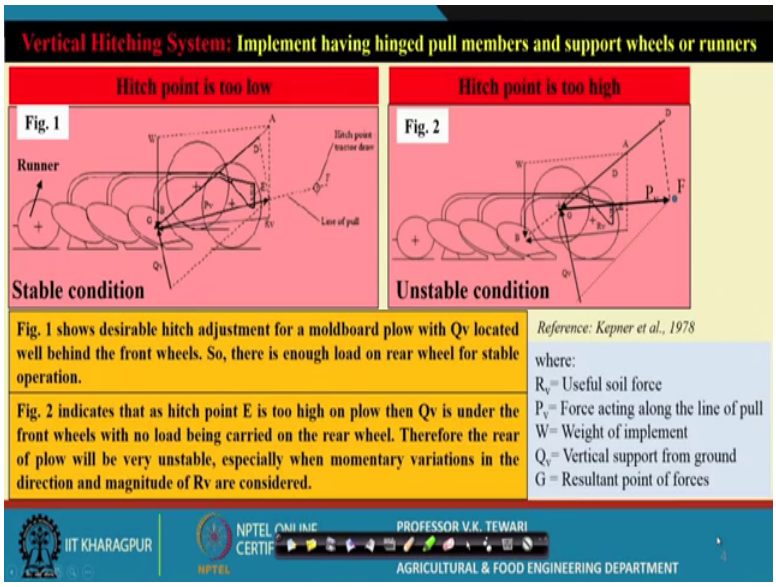


Let us have a look at it. Vertical Hitching System in fact, the implement having hinged pull members and support fields or runners. There are 2 conditions, which we encounter. Actually, when larger implements or hitched to the single edge point. We will talk of the trailer at some other point of time in our course of these lectures, but we will just talk of the implements particularly the moldboard ploughs.

We have a look at the moldboard plough have a look at this figure one here, well have a look at figure one figure one here. Here, there is a runner we can see that there is a runner here and these are the ploughs and this is the location where, we this particular

implement is hitched you can see that there are 1 2 3 4 these are the positions where, this implement can be connected.

Now, when this is connected to the hitch point of the tractor, you can have a look at this that the hitch point of the tractor drawbar is somewhere here. Which is in fact, when we are talking of the line of pull, we are talking of the line of pull which is in fact, a line which has already been explained to you, that it is a line which is joining the center of resistance which is at point G over here and the hitch point. So, this is the line which is the central of line of pull from the center of resistance to this.

Now, what important point is to be noted here is the hitch point is too low, when we are attaching to this point the lowest one, the hitch point becomes very low, but then advantage here is that then this runner is in a position to take the load. And, then maintain a position of depth of the operator with respect depth of the implement with respect to the tractors operation. And therefore, we call this to be a stable condition here of the system of operation, when the field is being ploughed with this particular implement.

But, then if you see the second figure 2 here. The runner is still there, but what has happened is now instead of the lowest one, it has been fixed to the a higher position here. So, the moment you put to a higher position, what happens? That, the position of this G the center of resistant here is shifted forward at this location here, this location here and; that means, that once this location is the implements get lifted. And, when the implement gets lifted? Then, this particular [hill/wheel] is this runner wheel is also lifted. And, then it is not in a position to operate or maintain the depth of operation. And, that is why this condition we call a unstable condition.

The rear of plough will be very unstable, when momentarily variations in the direction and magnitude of R v are considered, because this is the R v force this is the force R v here.

And, these force over here. In case of you see the condition of this, now we get this particular parallelogram here. And, in this case we are getting a situation which is like this here, but ultimately since it has been shifted we are getting a situation like this here. Where P v is the resultant where shifted here. Also, it passes through the point P F here, but then it is not a stable condition, and it will also not maintain the depth of operation.

As, in case of the stable one a uniform depth will not be maintained there will be a depth definitely in this, but uniform depth will not be maintained although both are hitched implements.

So, it is important to understand that if the hitching of these implements are done at proper location on the drawbar with these points here, then you will get a stable condition and a unstable condition. Stable condition will help you to maintain uniform depth of operation and unstable condition will not allow even the runner to maintain a certain depth operation, as the as well as the G will also get shifted here.

And, there will be unnecessary load on to this and we will not be in a position to utilize the whole capacity of this particular equipment this is important.

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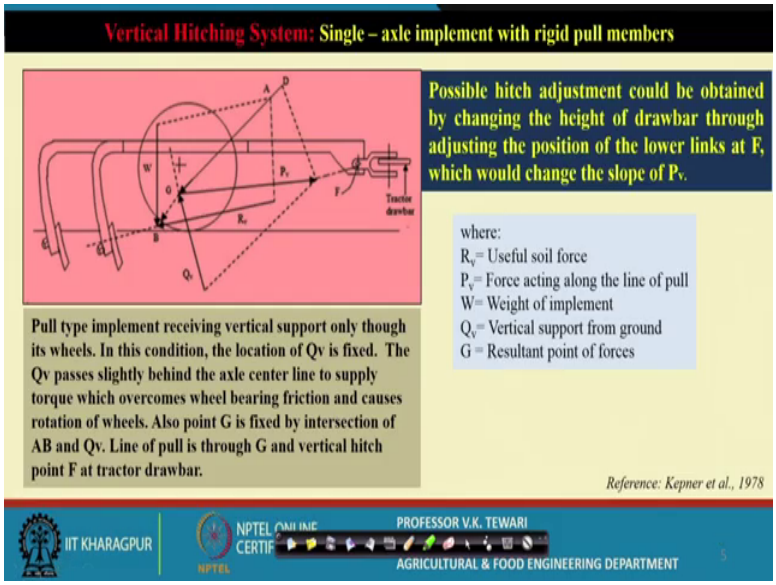


Now, well now we will go to another case where, again we are attaching the implement to a single point where, we have the hitch system possible hitch system could be obtained by changing the height of the drawbar well. We know that the when the drawbar is here, if we want to change the position of the hitch, we can shift the location of the drawbar by changing the position of the lower links.

So, when we change the position of the lower links, we can do this part height of the drawbar can be change, adjusting the position of the lower links at F this position. So,

that we we can do this part of it now, this type of full type of implement you can have a look at this, the line of pull is through G and vertical hitch point F is at a tractor drawbar.

So, this is the location where, but the point of hitch is here and G is at this position. Now, there appears to a slightly better condition of operation in this case as compared with previous implements, but this is a rigid pull type of member. Earlier once we had a wheel there and there was no rigidity with respect to the manufacturing of this or with the frame of this as compared to the previous ones.

So, here we find that the hitching of this rigid pull member or the implement is at a elevated position or a position where we want to have, wherever we want to have we can use this and the center of resistance is at point G here, and the force is the way we had talked of the R v R v, and P F are connected which pass through the center line and which pass through the hitch point as well as center of resistance.

G the point G is fixed by intersection of A B and Q v this is quite natural because the locations where the forces are acting of the weight of the implement, as well as the the soil forces. So, this position remains same here, but then the whole mechanics will change , but it , but it has a case particularly when it is rigid pull member.

Now, in this case what is so, important is the Q v passes slightly behind the axle center line to supply torque which overcomes the wheel bearing friction and causes the rotation of the fields this is important. See Q v, this Q v force is this is the Q v force here. Q v passes slightly behind the excess center line of the pull. So, slightly behind the axle center line of pull to supply a torque, now this torque will help us in overcoming. These curves will help us in overcoming the friction bearing. Now this is the one which will help us in overcoming the varying friction and then causes the rotation of the wheels. So, the wheel will rotate and the implement phase will be in a position to move.

Now, this is the tractor rear wheel this is the tractor rear wheel. So, what has happen is this G has come inside the tractor wheel. This is as compared to the other ones this G has come inside this and it will help us in hitching taking the implement forward by creating this torque, which will overcome the varying friction and then move away move the tractor I mean help this in moving the tractor forward ok.

Let us go to the other side when we have discussed about the single. So, I just wanted to show you that if we compare the conditions here of the pull type implements being hitched. So, the conditions are here you can see that the wheel, where is the location of the wheel here? And, what is the location of the wheel in the other cases? In the stable condition you can see, where is the G here? It is away from behind the wheels, where it comes inside in case of unstable condition, which is not acceptable and then when we go to this condition it is falling in between this.

So, these are the 3 different conditions under which the implements are test. Now, it is when it depends on what type of implement you want to use and what is the condition in which, it has to be of the soil as well as the total output capacity of the implement and so on and so forth.

But, then one must look into that these single point hitch implements or very large implements and they are used with very high horsepower tractors, which in these conditions are not very much in use, but with water important is the single point, which mostly used once or the trailers or the for the haulage operations we will discuss that slightly later.

Then, now we will talk of another aspect of this condition.

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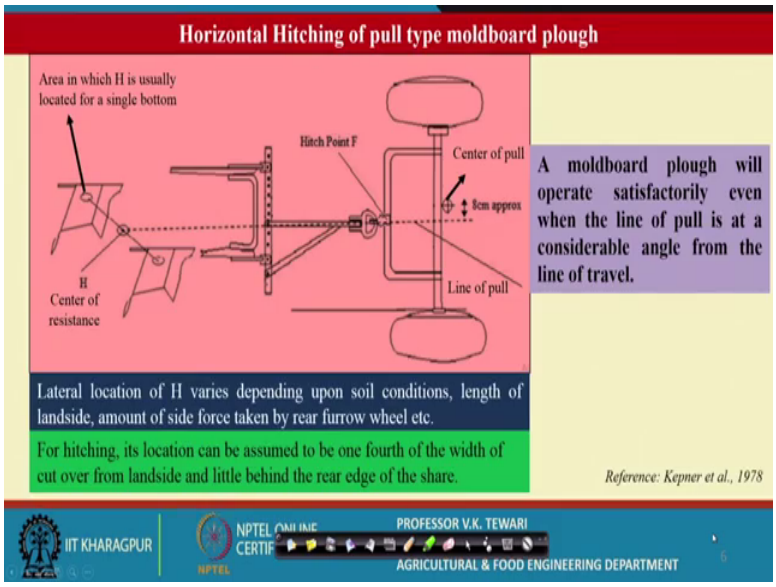

See horizontal hitching of pull type implements. Now, those we had seen the vertical hitching where, the hitching was in a vertical plane. Now, when we talk of this pull implements being connected in the horizontal plane, we can see that this is the drawbar here and this is the hitch point at this location.

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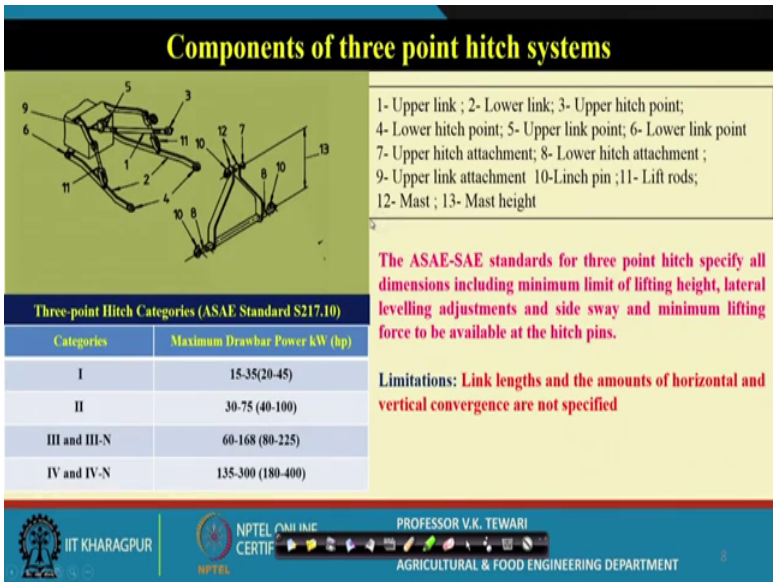


Yes, well we can see that this is the plough, this is the top view of the plough, we find that the center of resistance is the at this location. And, this is connected to the hitch point now you can see the hitch point is over here. So, it is following the center position here.

So, the line of pull is if you see this is the line of pull in this condition. Now, moldboard plough will operate satisfactorily even when the line of pull is at considerable angle from the line of travel. This is the important part when we talk of horizontal hitching of this. Horizontal hitching of the pull type of implements will have this advantage, that even if there is certain inclination or even slightly more inclination even then, the operation will be satisfactory.

For hitching it is location can be concede can be assumed to be one-fourth of the width of cut over the landslide and little behind the rear edge of the share. Now, we has talking of these position; that means, the hitch for hitching it is location can be assumed to be one-fourth of the width of the cut, over the land side and little behind the rear edge of this is point which needs to be looked into location of H, this location of H varies

depending upon the soil condition, this H here, this is the position here. Now, this will definitely vary with this soil condition, the length of the land side and amount of side force taken by the rear furrow wheels.

So, the important positions are important aspects to be looked into are the line of pull and the hitch point and the center of resistance here, which will have a variation on the type of the soil, and the amount of the total length of these land side, because the that length the land side takes certain amount of force side thrust and maintains a clear furrow. So, it will also have that. So, depending upon that force which the landside takes the location of H will have a bearing on that.

So, and the importance which I told earlier is that here, it will have a satisfactory operation even if the line of pull is at considerable angle from the line of travel yes this is possible the because, the line of travel if the if this is the here and it is slightly away then also, it will have a satisfactory operation, because the hitching is in the horizontal plane this is the importance of this.

Well, now in it is a separate thing whether we will be in a position to use this under what conditions this separate discussion altogether. At this point of time we limit up to this as to what is the horizontal hitching of pull type of implements? What is vertical hitching of pull type of implements? What are the locations? How they are stable? How they are unstable? And, what happens to the point of hitch as the central position, where does it go and which way it helps in the total operation of the implement with the tractor. So, this is what we discussed in these slides. Let us go forward and have look at some other aspects of the C G.

Well three point hitch. We, would like to have a three point hitch, which is the drawbar, which is most used and in fact, supposed to be the least effective. So, far as the power is concerned and the amount of power that we get from the tractor and you will find that in most of your problems and the designing you will be always talking of three point hitch. Well, when we want to know this three point hitching, we must know about what are these details of these components of such a H point or hitch sys[tem]- system or a hitching system.

Well, look at this figure here three point hitch categories are given here, but look at these here we have given all details of the components. For example, the upper link 1 is upper

link here, this is the upper link here 1, 2 is the lower link, 2 is lower link. Now these this is 1 lower link, this is another lower link. This is 2 3 upper hitch point now this is the upper link and this is the hitch point of the upper link 3.

4 lower hitch point now lower hitch point there are 2 lower hitchpoint, because there are 2 lower links. So, this and these are the 2 lower hitch points upper link point fifth is upper link point at what position this upper link is connected in the tractor body. So, this is the position 5.

Lower link point now where the lower links are connected this 6. Now, these are connected well this is not shown here, but they are connected at this position, yes it is shown here. This is position at which it is connected and this one is connected on the other side of it just opposite. Then, upper hitch attachment upper hitch attachment 7 is upper hitch attachment. Now, this is upper hitch attachment over here a lower hitch attachment.

Now, at 8 now this is the location where lower hitch attachment, then 9 upper link attachment here upper link attachment in this so, this position is the upper link attachment. Then 10th is Linch pin well, this linch pin is important when we are attaching the implement to this.

Then, Lift rods well, the lift rods are there this is lift rod here this is lift rod here, because they help us in adjusting the position of the links they help us in adjusting position of the links. 12th is Mast now this is these the mast here, which is of course, cannot be appreciated with this small diagram, but that once you have a look and you might have seen in the field I explained that this is the mast here. The mast height mast height is this, that position of this with respect to this. So, this is the mast height this distance is the mast height.

So, it is important to understand what are these where they are connected, the lower points the H the upper point, what are the connect their connections in the body, because then it when it they bigger implement is connected, whether it is a mounted type or a tilt type, you will find that the if there is a failure or if there is lot of load on to the implement, the failure takes place at these locations in the body of the tractor, we have seen in some of the experiments at one of the companies that the failure took place from

this location of the body of the tractor where the lower link was were connected. So, we had to look into the material of construction at that location.

So, it is very important to let you know as to what are these and how they are framed? How they are connected to the tractor? How they are connect? They are in a position to be connected with implement? And what are the other details this has been explained over here?

Now, since these are being universally used there has been a standard. And, that standard is ASAE standard S 2 1 7.1 which I have written here over here there are categories. So, category one belongs to 15 to 35 kilowatt about 20 to 45 watts per tractor, category 2 32 30 75, category 3 and category 3 N both well depends on the locations in some of the other European countries and all that 60 to 668 kilowatt horsepower and fourth and fifth is hundred 35 to 300 horsepower these are the categories, but we will find that in our Indian conditions most of this we will be talking of category 2. Category 1 is where we have been using the implements earlier smaller implements, but because of the more and more use of larger equipment for more and more coverage area and saving in time. Then, now we are shifting to 50 horsepower tractor 55 horsepower tractor and then that falls in category 2.

So, this will be the important category for us it is important to know that these are the category exist, because these are being used all over the world. The standards for 3 point hitch specify all dimensions including minimum lift, limit of lifting height, lateral levelling adjustments and side sway. And, minimum lifting force to be available at the hitch point, this is important to know what does this category mean? And, what are the important things, which have been universally used or being universally used by all of these people.

There, but there is a limitation of this particular H point, what is the limitation? The link lengths and the amount of horizontal and vertical convergence are not specified. So, one must know that, while these are very universally used and there are certain limitations or the values have been already fixed being to be used worldwide, we find that the link lengths and the horizontal and horizontal and vertical convergence are not specified, this you can be taken as the limitation of.

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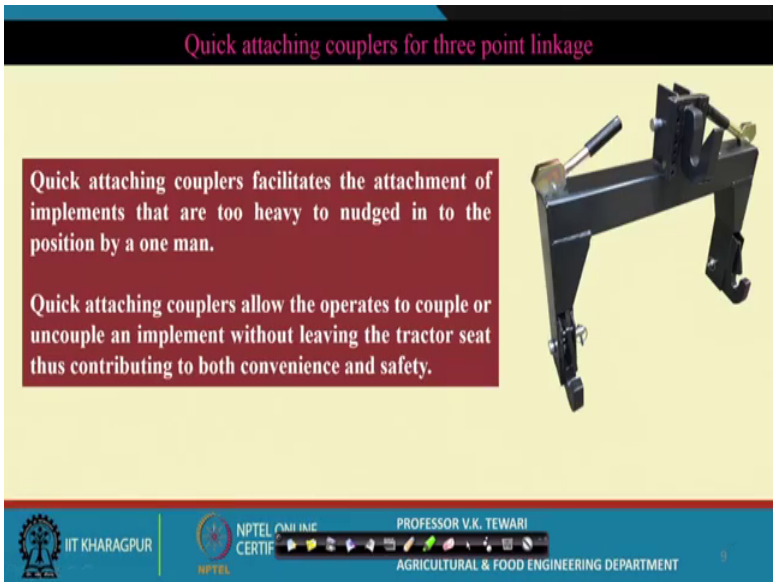


Another thing which worth mentioning here, you might have seen the hitching of implement the in the field, we had shown you. But there are very important devices or couplers which at which we call quick attaching coupler for 3 point hitch.

Now, the beauty here is that when this coupler is connected to the implement it will be easier for the tractor operator to just bring the tractor near and get it attached without leaving his tractor C; that means, you have might have seen that when it was attached in the field earlier case. People were trying to bring the tractor the (Refer Time: 27:52) were bringing the tractor near. And the other pay persons were there to put the hitch locations, and then this was being done and it took about 2 3 minutes of time.

But in this case it is that is why it is known as quick attaching coupler and it is very simple in construction many a places where you it is used saves time. Of course, there is a cost involved in that, but then does not matter one who wants to save time? And, who does not have people to help him in hitching he can definitely use this.

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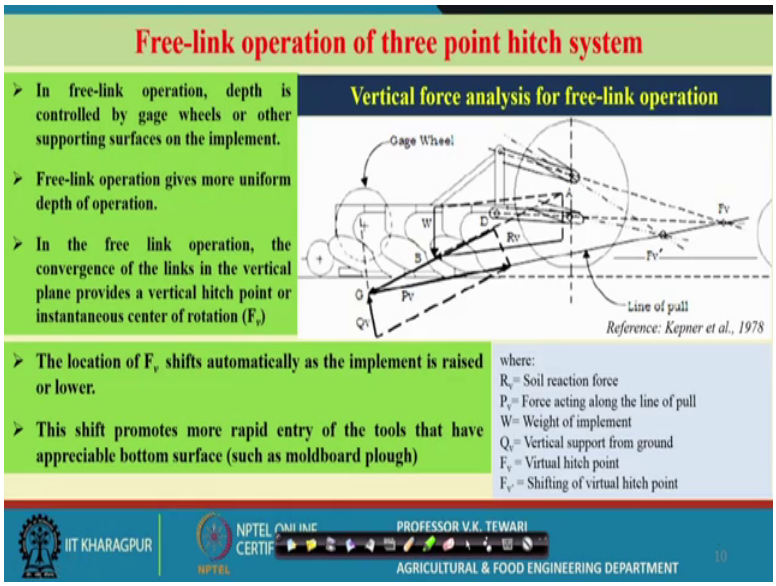


Free link of 3 point H system, we must have some information about this free link vertical forces analysis of free link operation. See location we it is very simple that as we discussed earlier that there will be gage wheel, then there is the center of resistance center of resistance here, where the forces of the implementer are here, there are the vertical force of the implement, then the soil forces and the forces in between the implement and the tractor while the tractor is being put.

So, the gage supports the gage wheels, supporting surfaces of the implement free link operation gives more uniform depth operation. Here, it gives more uniform depth operation, because it is field and this gage will it in facts gages the operation here this. So, it helps in this condition of operation and we have hardly any problem with regard to the maintenance of the depth operation. Because then depth operation if there is changing then maybe in the irrigation etcetera more amount of water will be at some location or the other. So, it is very important that we should have a free link operation where, we can get a uniform depth operation.

A location of F, shifts automatically as the implement is raised or lowered. Yes. Here this particular position of F, which is again in case of the 3 point linkage we know that this is the virtual hitch point. So, virtual hitch point this will definitely have a change in position as the implement is lifted or lower in course of it is operation in the field. And,

this shift promotes rapid entry of the tools appreciable bottom surface such as moldboard plough.

Well operate this operation is easier from this point of view that rapid entry of the tool takes place in this case.

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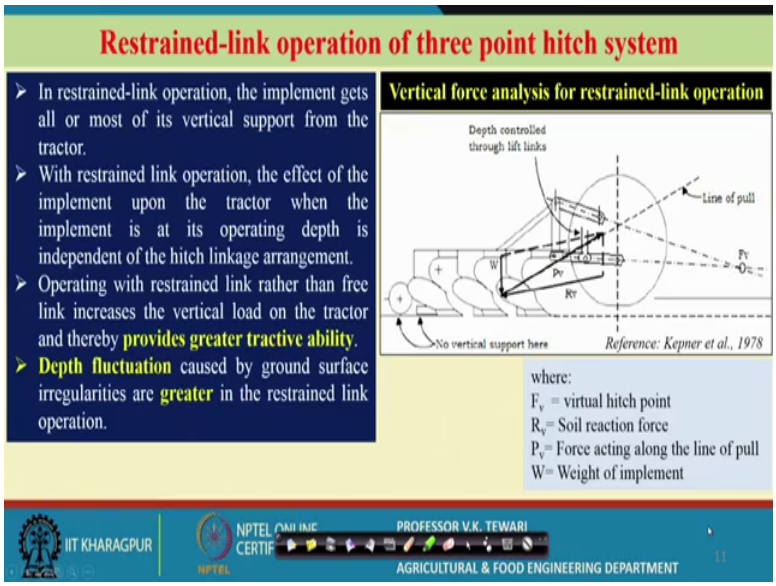


Restraint link, in restraint link operation this provides greater tractability of the depth fluctuations caused by ground surface irregularities are greater in this restraint link over here, but then it we are controlling by the hydraulic lever. So, the importance of restrained link here, you can have a look at this that the line of pull is shifted as compared to the other case. And, the restraint link operation the effect of the implement upon the tractor, when the implement is at it is operating left is the independent of the hitch linkage arrangement. This is the important things with respect to a restrained link here.

And, it provides greater tractability attractive ability depth fluctuations, which are caused by ground surface irregularities are greater in the restrained link yes, but then they are taken care of by the hydraulic system of the tractor.

The in restrained link the implement gets all or most of the vertical support from the tractor. Yes. This is the important part with respect to when we cover the free link operation there here, whole weight of the tractor, whole weight of the implement eases

onto the tractor, and hence it helps in the pulling ability of the tractor as compared to the free link operation.

This is the well I think then in this course of my lecture what I have tried to explain to you is how the hitching is done with respect to single edge and three point edges. And what are the different types of forces which are acting into it, what is a three point linkage and what are it is specifications world over, what it is capacity, what is limitations etcetera. I think then we look into the other aspects of this system in my later course.

Thank you.