Farm Machinery
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Lecture - 10
Combination tillage implements for efficient land preparation

Well, welcome students to this particular lecture on Combination tillage implement for efficient land preparation. Here, before I take into the details of that it is very imperative to let you know as to why we are talking of economising everything. In fact, in order to in decrease the e cost of input, we have to and maximise the output. We have to think of the all the inputs and the manner in which they are utilized and the way the, these are put to the crop production system.

For example, if you want to economise on each and every input is starts from the seed fertiliser, fuel energy, machine energy and all that. So, when we want this we have to think of how and what equipments to be used. So, that we utilised minimum and get maximum output from the implement, we use less fuel, we get maximum output. Personally, we will utilised less, machinery less, actually the manufactured material, but still we get more output this is what is the aim behind all these precision agriculture that we are talking today.

In this line, it is very imperative to tell you that implements which have been used so far and you have seen the operation of those implements, you have seen. The operation of a moldboard plow whether it is a 2 bolt moldboard plow or a 3 bolt moldboard plow or you have seen operation of a disc plow you operation of a disc arrow operation of opt disc arrow operation of cultivator and so on. And so, 4th you have seen they have been all used with the single power source and there are weeds varying from 1.8 meter to 2.1 meter. And things like that they require a certain level of power from the power source.

But we have been talking always and as I told in one of my class that it is still a mystery as to how we can think of a managed or most optimum size of a equipment to match the size of the power source. This is still there because, of the situations which happen in this soil the because soil is viscoelasticity material. It with soil moisture it behave something differently with the soil strength it behave something differently. And therefore, one type of equipment may not be useful and may not be effective in all sorts of conditions of the

soil whether it is a black curtain soil or lateritic soil and sandy soil and so on and so, forth.

Therefore, we need to think into how best we can have an implement now if you think that the implement should be such that it does the operation we have also seen that when moldboard plow is operated at least 2 passes of arrow has to be given to create the soil tilth which is required for seed with preparation and planking. So, the amount of energy is spent the amount of fuel is spent for the tractor, which will much more higher and in that case that, we would like to think even then we are not getting a matching implement for this operation. The time required is another point of consideration, because lot of point is up lot of time is spent in tillage operations we see that, the out of total production about 30 to 40 percent of energy is spent on tillage itself.

So, we have to think of some innovative way of using this machine energy the fuel energy and saving the time. In this line, of thinking we have now over the years. In fact, if you see the condition of the European and other implements. In the west, they have been using large combination tillage equipment, but in India it is very recently started being used.

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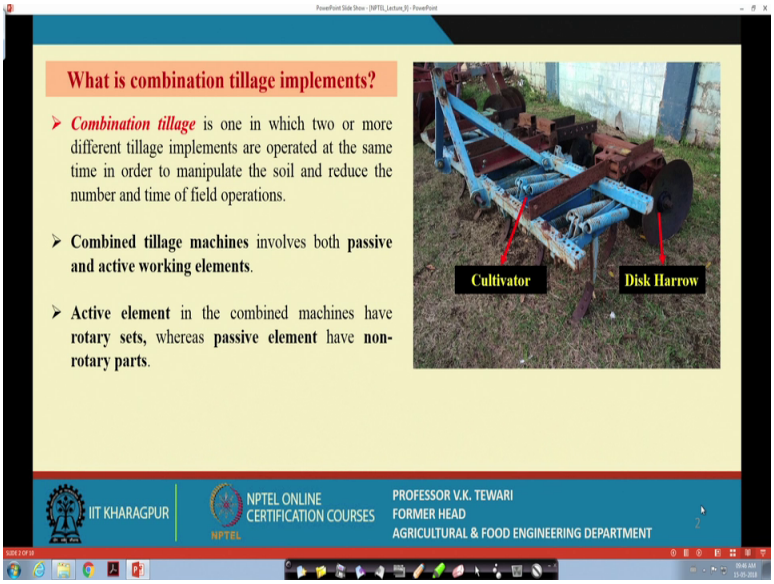

What is a combination tillage implement? Let us have a look at this and then we will discuss more details of these, what is the combination tillage implement well combination the name itself talks that, there is a combination of 2 items here we had

initially one type of implement say a moldboard plow or a arrow.

Now, the moment we talk of putting these 2 together we will talk of a combination. So, a combination tillage equipment is one in which two or more different tillage implements are operated. At the same time, in order to manipulate the soil and reduce the number and time of field operations very, very simple and very clear in the thought of what a combination tillage means.

Now, this combination tillage could be of different types why for example, if we have one moldboard plow, if we put another moldboard plow behind that or another disc plow behind that. You can say that, well both are implements which are being operated. Now, you can say that I if I have a moldboard plow if I want to put another rotter or rotavator. This is another set of combination you can have a combination where, we can put a rotavator in the front and we can put a cultivator at the back.

Now, if these combinations are taking sometimes is also said that one implement is in the front of the tractor and the other implement at the back of the tractor. We have done some work also, then maybe the plow is in the front and at the back, but then that requires different arrangements. Forthe balancing of the tractors total cg and the weight transfer which takes place for the front and the rear those many things are to be considered, but this has also come into play where people talk of equipment. In the front and at the back, but generally when we are talking of such combination tillage, we are talking now that it will be all attach behind the tractor.

So, this could be of 2 types mainly passive or active now these are this these are the 2 main. Types of the implements combination tillage implements that we are talking of passive active elements sorry active elements in the combined machine have rotary sets and passive elements have non rotary parts.

So, very clearly said that well when you talk of a combination tillage and if you have both the elements or both the implements, which are passive that is non rotary type. That will be called passive, if you have in one which is rotary had and the other one is not rotary, then we will call active passive type of implement.

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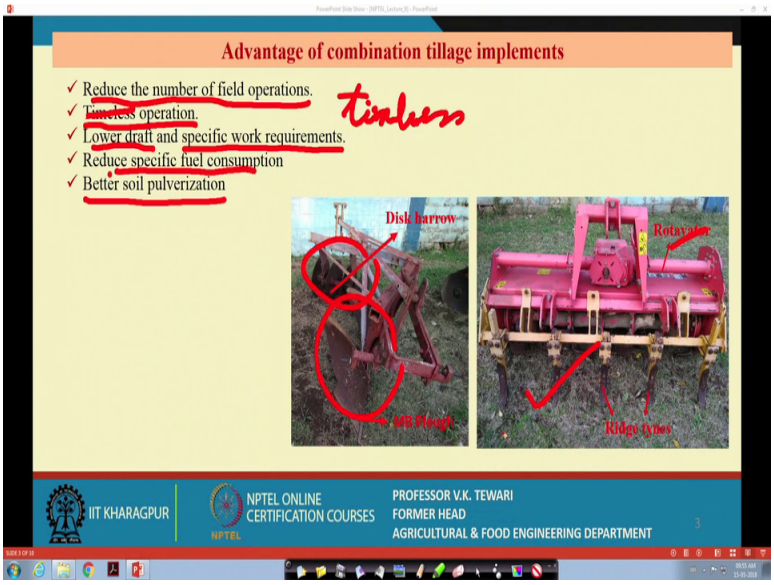

What are the advantages of this? Well this there large advantageous. In fact, if you go to look into the advantages of this, you will find that many things are taken care of and we are economising on several aspects first of all is the soil. If you have an implement which is cut first cutting the soil and the next implement going behind that is pulverising the soil or even planking the soil. So, you will find that the mean way diameter or the proper tilth of the soil which is required for seedbed preparation will be will be completed in one go. So, in one go or one pass of the this particular combination implement you will be in a position to get this desired soil tilth.

So, you will be saving time as in case earlier I said that you will have after the first ploughing operation may be twice operation of the arrow and then operation of the plow. So, in that case here, itself in one pass you will get this tilth made and once you have done this thing you have saved time, you have saved energy, you have saved fuel machine time and over and above, what we have done a proper soil bed.

In fact, it has also been found that the bulk density of the soil changes it has been found that the bulk density of change say about 1.4 gram per cc to it goes to 1.1 or 1.15 gram per cc. This is the bulk density which changes and the mean way diameter of the soil will also change. So, a proper tilth is obtained if in one pass you have very effective combination tillage implement. So, this is the important one

Now, so in that line, what we are doing? Reduce the number of field operations state

away as I said you reduce the number of pass. You do not have to go for several passes then time timeless operation. Well, in this is not timeless it will be actually timeliness operation, timeliness of operation actually; that means, operation will be completed in time or within the time and definitely saving of time saving of time saving of all the other inputs.

Lower draft now, this is one thing which we will see in the later course of these lecture, but lower draft and specific work requirements it will definitely take lower draft. If the general assumption shows that, see when the first ploughing has been done the soil is ready and the next equipment definitely requires a very less amount of draft to cover that. And since, the first soil has been open with higher force this will require lower force. And in overall you will find that an average force will be much lesser than what it would have been in the 2 cases earlier.

So, reduce specific fuel consumption yes, this as I have been talking of this that reduce fuel consumption. Sure, it will reduce because when we have one implement, opening in the soils and then twice operation of the arrow and then planking you can imagine that, what which be the fuel consumption of the tractor because a tractor if (Refer Slide Time:10:57) tractor also maybe a 4 to 6 liter or 7 litres per hour it takes. And that much, if it has operated for about 7 hours, 8 hours, then you can imagine how much will be the total fuel consumption at that time.

Whereas, in one pass you can imagine the same area will be covered and much less fuel consumption much less machine times. So, you can also increase the life of the equipment, life of the tractor and so on. And better soil pulverization yes as I said earlier soil tilth better soil tilth will be obtained because, the soil is pulverised properly when it goes. Here, there are certain things need to be considered as to how what will what will be the combination of this implement. Whether we want active or we want active passive? Or we want passive active which type of combination will give us the best result or best performance.

So, far as the soil tilth is concerned so far as the economising on the other inputs of the field preparation is concerned, we need to look into this. Here, we I have shown your example of moldboard plow and disc arrow here, a 4-disc arrow is her and moldboard plow is here, a 2 bottle moldboard plow behind which there is a disc arrow this is one

type of implement which is being used. The other shown here is a rigid time here it is a rotavator it is totally a rotavator here, in front and then here the rigid times.

Now, these the this is when operated the rigid tines this a 5 tine virtually 5 tine cultivator. So, 5 tine cultivator rigid tines the coming in the front and then rotavator is pulverising the soil at the back when the implement is attached with linkage and taking power from the pto. So, this is another equipment which we have at IIT Kharagpur and then we can use this.

Now, I wanted to just show you that these are the combination. Now, when we are thinking of this combination we have to think what should be the size? What should be the power source? What should be the arrangement of these which needs to be thought of as an engineer as an engineer you would definitely like what should I do. So, that I get with minimum input maximum output of field preparation a good soil tilth which will help me in getting better utilization or better germination of that seed.

So, let us go to the next slide where we will consider certain other aspects.

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Well I have tried to explain to you that a combination tillage implement is a combination of 2 types of implements together now let us see them slightly a objectively an analyse them objectively. For example, we know that there is a cultivator which we use behind the tractor and a rotavator which we use behind the tractor.

Now, if we take them separately and have a look at the total power required we will get some idea as to what should be the size of the total implement or the size of the new combination tillage implement which should be there because that should be within the capacity of the tractor which we have. Generally, as I said that we are now earlier maybe about 10 15 years back we were talking of category one where about 35 horsepower tractors were mostly used for all the operations.

But now we are talking of tractors we are 55 60 horsepower; that means, within the category 2. So, let us look at this here we are considering that this rotavator is operating at a speed of 3 kilometer per hour the width of the rotavator is 1.63 meter. And we know that rotavator has the blades it has in my previous lecture as I discussed with you, that there are blades. And those blades are cutting the different types of blades they are number of blades, sizes, disc, etcetera I have discussed all there.

So, I assume that you have an idea from their and we can straightaway talk about that rotavator here itself. So, power available at the shaft of the rotavator what is the power available at the shaft of the rotavator? We got from there that the power available at the shaft rotavator if you are thinking directly say from the engine, from the engine it comes to transmission and then it comes to the drawbar. And let us see that we are talking of pto in case of rotavator. So, at pto we have about 90 percent of the power 0.9 percent of the total power that we have here we are taking here.

So, if we assume even 80 percent of that. So, we are in a position to get with taking care of all the losses at the in a various locations we get that about 26.1; that means, about 20.8 at hp or 15.6 kilowatt is the power available at the shaft of the rotavator. This is the power available at the shaft of the rotavator when we consider; that means, we had a about a 30 horsepower tractor 30 horsepower 35 horsepower tractor and we are getting about 22.88 or 15.6 kilowatt utilize for operation of the rotavator here.

Now, if we see the condition of operation of a cultivator, this is a cultivator here cultivator. So, a 9 10 cultivator has been put here. We are operating at the same speed of operation at the same time we are having same width of operation. So, you see here 3 kilometer per hour and we are getting the same width operation.

Now, with this how do we find out what is the total force required? What is the total power required? We know the draft equation which I had given you the asae draft

equation which I gave you. In the earlier class, if you take that and if you recall that we can directly use this and find that the total draft is about 1005 Newton this is the draft which is required over here.

So, the power we will be then with the speed we can get that this is about 2.24 horsepower or 1.675 kilowatt. This is generally this has operated at about 10 centimetres or so the cultivator. So, we find that if you use this we are underutilising if you are use the cultivator, we are very much utilising the power of the tractor. If you are using this to a greater extent about 80 percent of the power, we are utilising because we are taking it from the pto.

So, we see here that the tractor is operated with the same width of operation with it is operated for certain period of time for a given area and it utilises so much of fuel consumption. Within this also utilises a certain amount of power now we see that if we add these 2 a total power of if P1 and P2 if we call this as P2 and call this is as P1 then therefore, the total power is this. Supposing, we would like that the same size of the implement is attached either behind the rototiller or in front of the. If the cultivator is either behind or a cultivator what will happen we need to think into this.

Now; that means, if we see that the total is 23.1 horsepower, where which will then say that the total power source with 35 horsepower source will not do this job. Moreover, we are just assuming this is a very simple and you can say novice addition of power because, we have not been in a position to exactly put them together of the same implement and find out. We can just we say that let us add this and see what happens.

Now, with this then we will be in a position to tell you that the power required is not only 35 horsepower. We will required a higher horsepower of the tractor so this says then that the implement which you are talking of whether a cultivator or rotavator you have to think of what should be the size of that, what should be the size of the blades, what should be the size of the total equipment, at what speed they should be operated and so on and so forth.

They need to be thought of and hence it explains to us that there is a requirement for thinking about the passive part or another passive part or active part and the next passive part or passive and active, all these parts we need to look into the draft requirement, the power requirement and the total work done.

Because, ultimately what we are interested is we are interested in how much is the power output that we get and that power output is this amount of specific work done by the equipment the combination tillage equipment.

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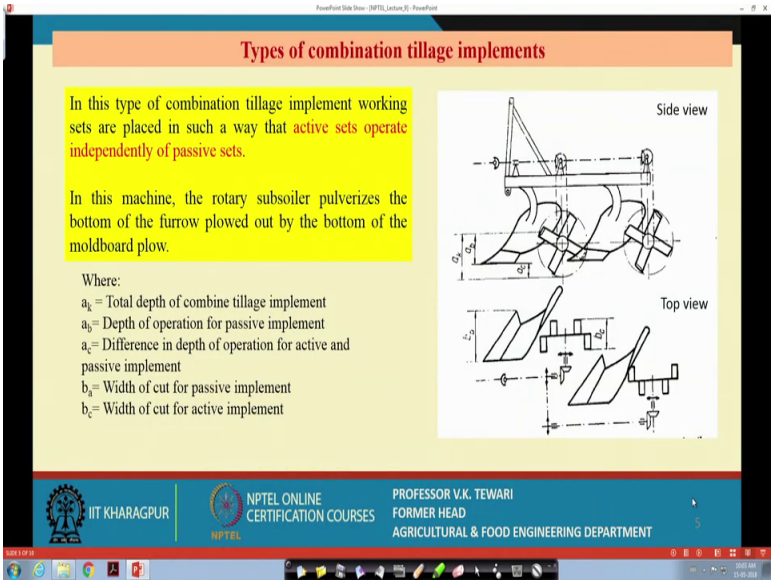

So, let us go and now look into these type of equipment which are going to be called as combination tillage and what should be the combination whether active passive, or passive active? Which way what are what people have done earlier we will have a look at that and we will think of a particular design. Types of combination tillage implements the active sets operate independently of passive sets

Now, there are 2 types of arrangements which have been shown in this particular drawing. Here, one is where active sets operate independently of passive sets, in this type of combination. In the other type of combination, the rotary subsoil pulverises the bottom of the furrow plowed out of the bottom of the moldboard plow.

Now, in this combination here, we want to show that this is the moldboard plow here, this is the rotary which is here, is connected by a power source from here taking power from the pto and this is connected over here this is the rear one. So, we have a combination here where the plow is slightly above, you can see that ak is the total depth of combination tillage.

So, ak is the total depth here, ab is the depth of this plow here, ac is the depth of this

difference in the depth of operation of the active and passive implement this is the one which is rotating. So, this becomes an active implement and it is depth is ac which is lower than a b ab is from this to this ac is this. So, ultimately we can say that this rotary one is working below the depth of the moldboard plow here and same thing the previous 1.

Now, we will see the plan view of this is the side view here if you see the plan view here we can see that the, this is the width this is the width of the moldboard plow. And this is the width of the rotor which is here and this portion shows here that there is a power transfer because the power this is the rotation in this direction here and the rotation here will be in this direction. So, when we operate this is at 90 degree so for that this is 90-degree power transmission, which has been shown over here in these. So, these side view and top views very clearly show that when you have a combination tillage over here.

We find that the rotary subsoiler pulverises the bottom of the furrow plow by the bottom of the moldboard plow. So, whatever is done by this moldboard plow, it is pulverising the soil. So, it is going slightly below the depth and then pulverising the whatever soil the front moldboard plow has plowed it is pulverising this is one type.

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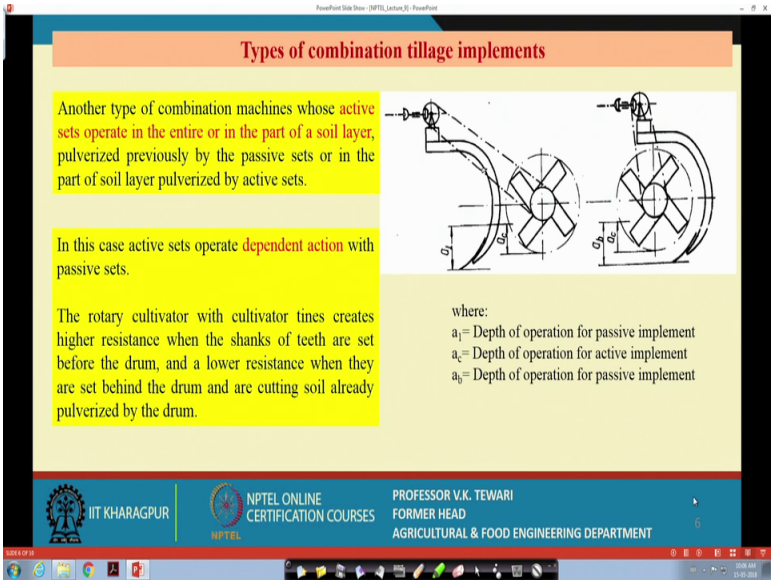

Now, let us have a look at the other type, another type combination here. We see that in this combination the active set operates in the entire or in part of the soil layer now you see here this is a one depth operation of the passive implement. This ac depth operation

of the active implement this is the active implement, as we have seen the earlier case is also taking power from here and operating this in similar manner this is the rear one.

Now, you see that a combination could be that this tine is in the front and the rotor is at the back you could have a combination. Where, rotor is at the front and these tine is at the back. So, what do we get the passive sets or in the part soil layer pulverises pulverised by active sets. So, what it says that, the active sets operate in the entire or part of the soil layer. So, this active operates in the part or part or total of the soil which has been pulverised by the front one that is with this one.

So, this is this does whatever it has done; that means, even slightly away it is slightly on the other side and hence the total area that, it will be pulverising is this in and this in this case, the sets operate in the dependent action with passive sets. In this case, the sets operate dependent action; that means, there is dependency on these.

Now, the rotary cutter with cultivator times creates higher resistance when the sank of the teeth are set before the drum. Now, when these are set before the drum this is what it says, that the rotary cultivator with cultivator tines creates higher resistance, when they are when the higher resistance, when the shanks of the teeth are set before the drum. If this is the drum and their set here, they are facing more resistance when they are put behind this definitely they will be looking less resistance. So, we say here that, if you have the combination tillage depending upon, what you want to do? You will be in a position to get the implement and then get.

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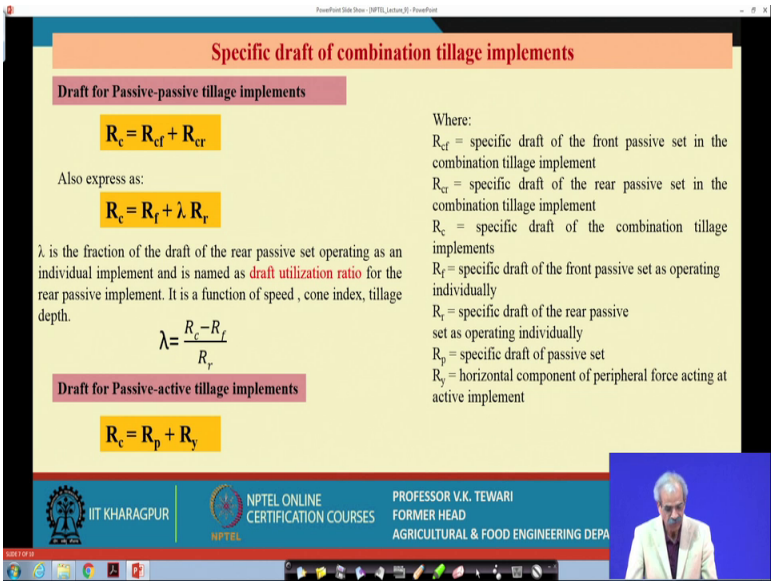

What is the size of the implement let us go ahead. Well what is the draft requirement? Well, if we have a passive implement and or active passive implement is very simple we have to add these. For example, Rc and Rcf and Rcr it tells that the specific draft of the combination tillage implement will be a combination of the passive set. In the combination tillage and the rear passive set in the combination tillage; that means, this is a passive condition here.

So, in a passive condition we must know what is the specific draft by the first one, what is the draft by the rear one? And it may also be expressed as suppose, we have an independent operation of these 2 then what may have that this Rc can be given as Rf plus lambda times Rr, where Rr is the specific draft of the rear passive set operated individually. So, in if it has of been operated individually then if then also we can get the specific draft of the combination by this formula here. And then this lambda is given by because Rc is known to us and Rf is also known. So, Rc minus Rf upon Rf Rr here, will give you a draft utilization ratio this tells us that, what is the level of draft ? It is which could be utilised if we have a combination like passive, in this case.

Draft passive active implement is then very clear we have Rc rp plus Ry. Where, Ry is the horizontal component of the peripheral force acting on the active implement. Definitely, because then the torque will come because the, it is acting on the see if this is the one where it works. So, it is like this and the centre. So, this will talk of the torque

this is the force here and this is the r value. So, that is why it says that the horizontal component of the peripheral force acting at the implement, it talks of this force here. So, if you add these 2 we will get the passive active tillage implements draft.

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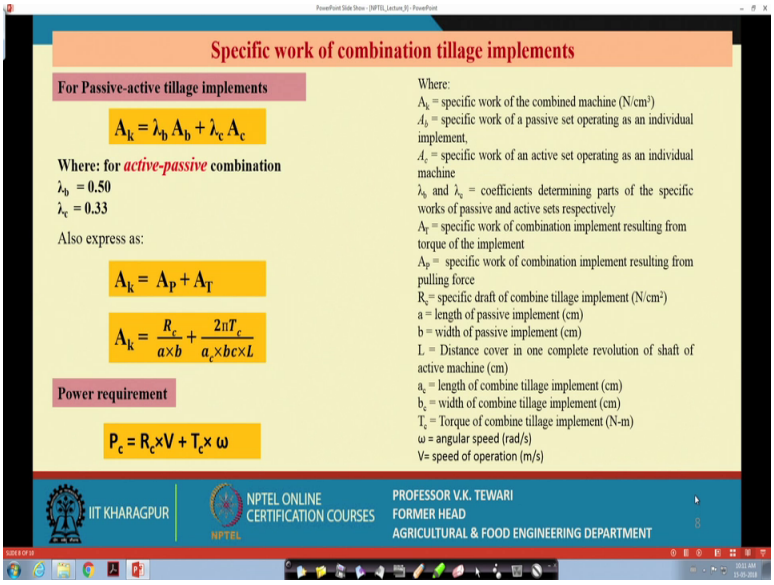

Well the most important and the next thing is how much is the total work done. We must know, what is the amount of work done. So, work done where passive active combination we see that this equation is given here Ak del lambda b, lambda Ab, then lambda c Ac Ab is the passive work a passive set operating at individual implement Ac is specific work. And active set operating as an individual implement, lambda b and lambda c are the coefficients determine the part of the specific work for passive and active sets respectively. This talks of this lambda b and lambda c talk of, what portion of these portion of the implements or portion of the work, is added when we have a combination tillage of passive or active.

So now question is what is the value of this lambda? Well there has been various researches, but still people are not very clear about this total value of lambda, but then in one literature we have got the value of lambda to be lambda b is equal to 0.5 lambda c as 0.33. And maybe when you have a active passive if this is the condition if you have a passive active maybe you can convert those values or interchange the values can use it this could be one way of looking at the whole thing.

Then it also expressed Ak is ap plus At here, Ap is the specific work combination of

implement resulting from pulling force here and At is the specific work combination of combination tillage resulting, from torque of the implement sure torque of the because that is the one which is helping us in getting the amount of work. So, these 2 represent the specific work of combination implement resulting from pulling force this then the torque this.

Now, if we want to detail this or we want to go further analysis of this we find that what is this work? It is a specific works. So, a specific work talks of we know what Rc is Rc is the draft of the combination tillage implement. So, if you know this is the draft per unit area is the a specific work that we are talking of here. So, Rc by a into b will be this and this is the one which we are talking of because t by c one will talk of the torque portion that is 80 and hence the area a b.

So, we will be in a position to find out what is the total area of the soil which has been work by this implement so total you can find out. Once we know these; that means, we have an idea about how much is Rc how much is Tc then we can find out the total power Pc which is given as Rc into to b plus Tc into omega because Tc is the torque which is coming on the combination tillage implement this is the torque, torque into omega will give us the power. In fact, twice by omega t and for a unit rotation then we should be in a position to get the power of this particular combination.

Thank you.