Course Name: Conservation Agriculture based Sustainable Intensification

Week 02-Lecture-1: Multi-Crop Zero Tillage Planter

Course Instructor: Dr. Mahesh K. Gathala, Sr. Systems Agronomist, CIMMYT, Bangladesh

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Hello friends. Today we will look at what are the machines that fall under the purview of CASI. We will focus on Zero tillage multi crop planter. We will explain what is zero tillage and zero tillage multi crop planter and what are the differences between the two? Zero tillage machine is a machine that does sowing of wheat without any kind of primary and secondary tilling just after the rice is harvest in a field which has 15 to 20 cm of anchored rice stubble. It drops seeds and fertilizers at the same time and in the same place. This technique disturbs soil to a maximum of 30 % depending on the crop. Crops like wheat have more soil surface disturbance as they have line to line distance of 20 cm where a crop like Maize which has line to line distance between 40 cm to 60cm will have soil surface disturbance of only 10 %. So a Zero tillage machine drops seeds and fertilizers at the same time and same place without any kind of tilling.

Now we look at how this machine first introduced to India. There are two or three reasons for this machine to come to India. First, our farmers do a lot of intensive tilling which harms the soil and also increases the cost. The second reason for it was that in the rice-wheat cropping system if we plant rice a bit late then its harvest also gets late which delays the wheat sowing by one month as farmers first plough their field. The wheat crop which should have been sown in the first week of November now gets sown in the month of December and this reduces our wheat yield. If wheat is sown in the month of November, then the crop production can be increased by 15 to 20% just by sowing early. Thirdly, because of practicing the rice-wheat monotonous cropping system, there was a problem of weedcalled gehu ka mama (Phalarismnor). So to address that problem this machine was introduced and it has proved beneficial.

The Zero tillage machine came for the first time in South Asia in the year 1980 in India and Pakistan. The first machine came to Pantnagar in the year 1984 under the supervision of Dr Bacchan Singh. It was an Atchisonmachine imported from New Zealand. This machine had to be locally modified as it had many problems like it did not have balance wheels, had no proper tines and the seed metering system was not good. So for these reasons this machine was not successful in the beginning. From 1985 to 2000, there was not much progress in this machine. It underwent at least 30 version modification and now we finally have the zero-tillage multi-crop planter. The most distinctive feature of a Zero tillage machine are its tines which are also known as furrow openers. These are special types and we call them T - inverted type of tines. If we reverse it, then we can see it is T shaped. So this is basically in an inverted T shape

The furrow opener has a high carbon bit (heated bit) for penetration and it is wider from here as it has to place seed and fertilizer in the proper place. Even in this, the fertilizer goes first and then the seed so there is some variation as the seed and fertilizer should not get in contact. So this is the Zero tillage tine and it is different from the shovel type traditional tine. We cannot use the shovel type tine in Zero tillage as it will make big clods and as a result, the seed and fertilizer will not germinate properly and greatly disturb the soil.

The simple zero tillage machine is a drill type machine and is made only for wheat/rice. Now, we will look at the difference between a simple machine and a multi crop planter. Zero tillage machines are made for continuous drilling crops where we do not need any plant to plant space like wheat, barley, mustard, jowar and some other crops. So the scope of crops that can be planted using a Zero tillage machine is limited. Now with a multi crop planter, we can do both things. We can drill as well as do planting. It has three boxes. The front box is used for fertilizer. The second box is used for seeds and the third box is used for special crops like maize that require precise planting. Now, we come to the balancing wheels. We had also discussed them yesterday as part of a happy seeder. We never use this machine on a hydraulic system. When we operate this machine we releaseit from the hydraulic system and this completely runs on the balancing wheel. The job of the balancing wheel is to control the depth at which to place seed and fertilizer and also to maintain the balance of the machine on both sides. If we want to place the seed at a greater depth, then we bring this up and if we want to lower the seed depth then we bring it down. So this was the balancing wheel.

Now, we discuss the important components and parts of this machine. This is our seed and fertilizer. This is our fluted roller for fertilizer and they have an opening underneath them from where the fertilizer drops through gravity after being pushed. By this, we can adjust the fertilizer. The second component we look at is the seed box. Like I said earlier, this is used for continuous seeding where we do not have to maintain plant to plant distance and they drop at a seed rate and they also have a fluted roller mechanism.

The third component is a multi-crop planter and it has an inclined plate system. It is used for different crops and it maintains plant to plant spacing.

This is its basic frame and tines are attached on the clamp. This is the balancing wheel and over there is the driving wheel. The job of the driving wheel is that it transmits power to run the seed metering system and we can do the adjustment as we like.

Now we look at the inclined plate. This is a medium type plate and has m written over it and is basically used for sowing directly seeded rice. We can also use it for moong and other crops. The other plate is a bit large and thick. This is used for maize. Now, we have two types of plate for maize. One is an L and the other is an extra L. If the maize seed is flat type, then extra L is suited for it and if the maize seed is round type then L plate is suited for it.

Now, we look at how to increase the plant to plant distance. These are the sprocket. If we want to increase the plant to plant distance, then we use the large sprocket which reduces its rotation speed and that increases the distance. If we want to do the planting at less distance, then we use the small sprocket. If we move from large sprocketto small sprocket, then its speed increases. If we move from small sprocketto large sprocket, then its speed decreases. So this is their job and they are used for adjusting it.

These are the two types of gauze, one at the front and another over here. This is to adjust the seed rate and this is for the fertilizer. This is a pull type machine and does not require any power. It is pulled by a tractor and it has no mechanism from where it can drag the power of a tractor. It only is pulled by it. Other machines like Happy seeder require the supply of power.

Now, we look at the adjustment and calibration of this machine. Before taking the machine on the field, we have to make sure that the machine is clean, if all the parts like fluted roller or chain are properly moving or not and if it has got rust. If this is the case, then we should clean it first. Now once it is in the field we have to make sure if the machine is properly balanced. If it is unbalanced, then it is either forward leaning or backward leaning. The two tines are attached to the frame or angle bar. So if it is forward leaning, then the front tine is more active and the seeds and fertilizer at the front will fall at a greater depth than the one at the back. So it is very important to have a proper balance of this machine.

Now, how do we balance it, if it is unbalanced? The tractor has a link called top link. We open the top link and can make it small or big. If we make it small, then the machine leans forward and if we make it big then the machine leans backward. So we can adjust it accordingly.

Now, there are sometimes when the driving wheel does not touch and becomes free and as there is no traction and it does not move and the transmission does not get powered. To fix this, we can increase its length to adjust it.

Now, we come towards calibration. They come pre calibrated and we have a manual that explains everything like at what hole how much kg of seeds and fertilizer will drop. But we do not trust it and to confirm it we run this machine for 30 to 50 metres with seeds and fertilizers in them. We take the row out and tie a polythene to it and collect the seed and fertilizer and observe how far it goes and also its width. If it is nine tine and is at 20 cm, then its width is 2 metres. If it is 1.8 to 2 metres then we can calculate the area. 1.8 times 50 equals 90 metres square.

From this we can calculate how much seeds will be required for any given field like a 10,000 square field. Accordingly, we adjust the seed rate and calibrate the seed and fertilizer. So if 90 gram is needed then for 1 hectare we would need 90 kg.

There are other minor things in calibration like with this we can control the speed. We can maintain plant to plant distance with this. For using different crops, we have to use different inclined plates like for rice, Maize, mustard and other small crops, there are different inclined plates and we can also change the speed. For continuous seeding crops like wheat, jowar and other crops we can put the box in it and then calibrate the seed rate.

For crops like maize, we calibrate it according to the number of plants. In 1 hectare we have to plant at least 80000 to 90000 plants. In order to do that, we observe a 1 or 2 metre line and notice how much seeds are falling into that. If 10 seeds are falling, then it is fine but if it is less than 10 then it is not enough as we require at least 20 cm distance between plant to plant. So basically, we count and if 10 seeds are falling in 2 metres then that means that our calibration is fine but if only 3 or 4 seeds have dropped then we will have to increase the speed and we can then calibrate it.

Now in the end we look at maintenance. As the season finished, the first thing we have to do is wash the parts. If there is some fertilizer left in the box, then it would rust our box and damage our fluted roller and in the next season we will have to replace all the parts. So it is important to

wash the box after the sowing season and where ever there are any bearing, gears or bush, we have to grease and oil it. We can also detach the box like for wheat sowing.

Earlier the old models of zero tillage machines would have tines that would come as a single part. So if it broke then we would have to buy the entire new part. Nowadays, the parts are separated like furrow openers and tine are separated. So we replace only the broken or damaged parts. If any part is worn out after being used in for the entire season, then we can detach that part and replace it.

Anywhere where there are joints, we have to grease and clean them. When the machine is not in use then we should keep it in shade or cover it so that it remains maintained and rust free and then we can use the machine for 10 to 15 years.

Thank you.

Course Name: Conservation Agriculture based Sustainable Intensification

Week 02-Lecture-2: Mechanical Transplanter

Course Instructor: Dr. Mahesh K. Gathala, Sr. Systems Agronomist, CIMMYT, Bangladesh

Hello friends. So far, we have looked at the different components of CASI. We looked at one of its components called Mechanical Rice Transplanting and why we needed it. The most difficult task in rice cultivation is its sowing/transplantation. We do puddling and then transplant seedlings and for this we have to stand all day in the field. This work is mainly done by women and our young generation. By standing and working all day, we get hand and various body related ailments. Basically, the process of transplanting involves a lot of drudgery. To avoid doing all this and to overcome the shortage of labour, we started to work on a Rice Transplanter. Its demonstrations began in the year 2001 - 2002 in India and the preliminary research showed positive results.

So what does it have? It requires a Mat Nursery which is a special component of this machine. There are two types of this machine. Earlier, we had only one type of this machine in India and it was the floating type machine which is the one we are seeing. The other one is a hydraulic or running type and it is more efficient and light.

This is a floating type mechanical rice planter. We keep the Mat nursery over here. According to this, we adjust the depth of the Mat nursery and this is a finger and it takes each seedling and plants them down on the ground as it moves forward. Mechanical rice transplanter plants the seedling on ridges. As it moves forward, it creates ridges from here in the middle. This floats and this presses it down and it goes up where our seedling gets planted as it moves forward.

There are two levels of depth adjustment. The distance between seedling and plant is 12 cm and 14 cm and we adjust this distance. This has a line to line distance of 22 cm and we can also adjust it a bit. We can't adjust this on a floating type but it can be adjusted on a hydraulic or running type.

So this is what we call a mechanical rice transplanter. Now, we would look at its components. This component is called a rotating flat board and its job is to facilitate mat nursery. Its distance is 22 cm. This is a finger controller and it has fingers which we rotate. Besides this, we have a floating platform and it floats over puddled soil. This is the engine and its components. This is its belt. When we release it, the fingers get activated and it acts as a control to turn it on and off. This is the adjustment where we can adjust the distance between seed and seedling from 12 cm to 14 cm. If we have to take this to the road, then this is the gear system and this is the high gear.

This is for adjusting it and is used if our floating system gets jammed and we adjust it to release it. These are the two platforms and two people are sitting on it to feed the mat nursery.

Besides this, we have pads and it is a very important part as it brings down the mat nursery as it gets empty and also takes it from one direction to another. As it moves forward, it changes direction as the mat nursery is emptied. This floats the mat nursery so if there is any gap then it does the adjustment. This is to make ridges in floating type and this is a wheel which is used when we have to transport it on the road and we take the wheels out when the machine works on the field so that it can float.

This is to control the seedling depth. If we have more depth, then we open it up. If we have to reduce the seedling depth, then we have to bring it up. Along with that, we have these two adjustments and its job is to adjust the number of seedlings. If our mat nursery is too thin or thick and if we want to keep the seedling from 2 to 4 or from 4 to 6 per hill, then we can adjust them with those two adjustments. So, if we

have to place less seedlings, then we open this and adjust that accordingly and this adjust the number of seedlings. So these are all the important parts that contribute to the machine's functioning.

Like I said earlier, there are two types of mechanical rice transplanter. The first is a floating type which we just looked at and the other over here is a hydraulic or running type. This has more adjustments and is more efficient. The mat nursery is also more efficient and this machine is comparatively easier to transport from one field to another as it has a hydraulic system and has good speed. This also has mainly two variants. One is a 4-line system and the other is an 8-line system.

We looked at the floating system and it also has two variants. One is a 4-line system which is used mainly by small farmers and the other is an 8-line system which can plant 8 lines in one go with this.

The floating type is less efficient and is not easy to transport from one field to another. But on the other side is a Hydraulic or running type and it requires no floating mechanism. You can see that the platform runs on wheels and is not a floating type and its speed is also higher. It also has two variants, one is a 4-line variant and the other is an 8-line variant. It also has a high efficiency variant which is an eight-line system and can run at a high speed.

But, we are mainly catering to the small farmers of India and for them the 4-line variant is more efficient. There is an 8-line variant available as well. This is how they work but the hydraulic variants have more adjustments which you can see. They have more row to row and plant to plant adjustments available as compared to floating variants.

Like I told you earlier, both the floating variant and the hydraulic variant require a special type of mat nursery and it has a different way of preparing. There are two ways of preparing the mat nursery. The first is using a tray of exact dimensions which we fill with soil and put/slide it in. The other is a local way of preparing on a polythene mat. Mat nursery preparation is difficult to do on a small farmer to farmer scale and is more suited for doing on a large scale in a custom hire center. In this way, we can provide both machine and mat nursery services to farmers.

Now, we have both the types of machines with us i.e. hydraulic and floating types and both of these have similar maintenance requirements. We get a user manual for both these machine types and it is very important to read it before doing any sort of maintenance. I will present to you some of the main maintenance.

First, we need to grease and oil the components properly. We need to make sure there are no stones or pebbles in the fingers and if any finger is broken then we need to replace it. Also, if the mat pad has broken down or is damaged then we need to replace it. We need to make sure that the floating roll is greased too well. Also, the power mechanism shaft has pins that need to be replaced if broken.

Second, on a floating type, it is important to close the seedling during a turn instead of releasing it as it can break and we can start it again after we have completed the turn. Such a problem is not available in the hydraulic type.

We also have to see if there is gear oil as it can break if it is too dry. It's engine needs maintenance and repairs just like a tractor engine. We have to only use filtered oil and also clean the filters of the cooling system.

Again, the gear box needs to have oil and if it's leaking oil due to seal breakage then it needs to be fixed.

These are its main parts. Hydraulic has slightly different parts because it's technology is more advanced but still its principle, maintenance parts and mechanism are the same and only the machines are different. Accordingly, both of these have manuals and we need to take care of their maintenance accordingly.

Now if we talk about efficiency, then in a day, it can do planting in one hectare. This is for an 8-line variant. The 4-line variant will have half the efficiency of an 8-line variant. In the same way, we have efficiency of the Hydraulic type and it has more efficiency because it is a running type. These days, the floating type comes with a seat arrangement. The hydraulic one has two variants. One is a walk behind variant and the other is with a sitting arrangement. Both the hydraulic variants have their respective prices and are available in the market.

So friends, we learnt about what a mechanical transplanter machine, its different components and how it works. Now, we will look at how this works on the field, understand and observe all its steps and then help farmers with its functionality and if they face any problem with it.

This is a labor saving technology and it has health benefits for the community especially for women. So this saves time and labor and frees women from drudgery as they no longer have to stand all day in water and do transplanting. This is a very good machine as it does mechanized seeding and it will generate employment in the rural sector.

Thank you.

Course Name: Conservation Agriculture based Sustainable Intensification

Week 02-Lecture-3: Happy Seeder

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We learnt about CASI in the previous session. We studied the three main principles of CASI - minimum soil disturbance, crop residue and crop diversification.

Now, we will look at crop residue. We require machines to manage crop residue like how to do seeding and planting.

We now move to crop residue management. After using combine harvest we have around 10 to 12 tonne of crop residue in the field. When manual harvesting is practiced then there is no crop residue and we can use simple machines. But where a combine harvester is used like in rice-wheat or any other cropping systems, then we have a lot of crop residue and face a lot of problems during seeding. If we use a general machine for seeding, then all the crop residue is dragged by it and the machine cannot even cover 2 metres and we face a lot of problems.

To overcome this problem and develop a new machine, both Indian and Australian governments, PAU, CIMMYT, Rice- Wheat Consortium and IRRI worked together on a project to develop a new machine called Happy Seeder.

Happy Seeder project started in 2001 and over the years till 2019, there has been 15 different iterations of this machine. The first prototype had a seeding mechanism but it had lots of problems. The first problem in this prototype was that it required a lot of power, almost 80 to 100 % horsepower. The second problem it had was that it would first lift the residue, then the seeding mechanism would work and then it would throw it and this created a lot of germination problems. A lot more work was done on this machine and finally we got a very good prototype.

Happy seeder is a machine that can sow seeds and fertilizer in a single operation at the right place without any kind of tilling and soil disturbance. It works on any field with evenly distributed crop residue be it rice or wheat or maize and that has a load of 8 to 12 tonnes.

These are pipes where seeds and fertilizers go and these are our furrow openers and flails. This is a power operated machine. These are flails and if any residue gets stuck then this runs reverse and then places the seeds and fertilizers. After placing the seeds, the residue is not above the furrow so there is no problem during germination. This machine can work easily with every type of crop residue of any crop with a load of 10 to 12 tonnes and without any problem.

Like I mentioned earlier, this machine is power operated. This is our Power take off (PTO) and this gets connected and we get the power transmission supply. But the Happy Seeder, needs a double clutch tractor to work and it cannot work with a single clutch tractor. It has RPM that is adjusted so we need a double clutch tractor. This is the gearbox and it provides us with the needed force which is between 400 to 500 rpm to run it. If the rpm is less or more, then either it

won't cut the residue or it would require a lot of energy. So to adjust this, we require these gears and they push them forward in a uniform force of 400 to 500 rpm.

This is the gear box and it has rotor flails in it which rotate against the forward motion of the tractor. So they runs and rotate in the opposite direction. If it rotated forward, then all the residue would fall in front and that would have created a safety issue. All the other rotary and tilling machines work with forward movement but this one works in reverse.

This is called the driving wheel and as it rotates, it powers the seed and fertilizer seeding system. It has chains and has different gears. If we want to change speed, then we have sprocket of different sizes. If we want to increase the speed, then we use a small sprocket and if we want to decrease the speed then we use a large sprocket.

This is the seed and fertilizer box. There is also a third box attached called inclined plates that is used for multi crop planter. Right now, we just have two boxes i.e. a seed and a fertilizer box.

Now the back portion of our seed and fertilizer box has a fluted roller system which is used for seed and crops. This is only used for crops that have continuous seeding for drill type seeding. For spacious crops, we have another box attached from which an inclined plate comes out. This is a pipe and it attaches the seed and fertilizer with the furrow opener. This is a T inverted type furrow opener and it is exactly in the shape of T. It makes a slit and only disturbs 3 to 5 cm soil and drops the seed and fertilizer.

These are flails that are attached to the rotavator. When this runs on the residue field, all the residue gets dragged on the tine. This rotates in reverse and then either it will cut or remove it by heating and thus clear our line. Where the seeds and fertilizer are placed, the line is clear and we get good germination and we don't face any problem as we have removed the residue.

This is the structure or frame and it is well covered because it rotates around 400 rpm and if at that rotation speed any stone or stubble sneaks in then it can get damaged. So we have to cover it.

We also have these rubber flails and it stops all kinds of stones and stubble. Now the specifications of this machine are mentioned here. Its name is Happy Seeder. It has nine tines which means that it can seed nine rows in one operation. It needs a minimum of 45 horsepower double clutch tractor and its weight is around 740 kg. Wheat is mentioned as the crop but we can also do other crops with it like oilseeds, mustard, lentils, chickpeas, maize and even rice. To do all these crops, we have to attach a multi crop planter box. This is the shaft of fluted seed and fertilizer and it has a mechanism to increase and decrease.

Now, we look into the seed and fertilizer calibration. This is for fertilizer. If we increase it then more of it will drop and it is in terms of per acre. If we want to drop 22 kg per acre, then we have to increase it and it is in the fraction of 1:5 so 1 multiplied by 5 kg. There is a calibrated version of it as well but we cannot trust that and instead calibrate on our own in the field. I will explain how to calibrate ii later.

This is calibration for the seed and it is exactly the same as for fertilizer. There is also a manual guide that comes with it. We don't have that with us right now but we can provide that to the farmer or operator and he can make his decisions based on that.

These are the depth wheels and these are very important. Every crop has to be sown at different depths. Some crops have to be sown at 2 cm depth and others need just 1 cm. So for that we have to adjust the depth from here. If we want to increase the depth, then we have to raise it and if we have to decrease the depth then we have to lower it. By lowering it, the tine goes up and the depth falls. But for that we have to maintain the same level of both these depth controllers, otherwise one of the sides will seed more and the other less due to variations in depth of controller. So it is important that seeds and fertilizer drop at the correct depth in all the nine rows.

Now, we will look at calibration, adjustment and maintenance. When we use a traditional combine harvester, all the residues come in one or two metres and in the rest of the area there is no residue. In 1 or 2 metres within the line strip, there is a lot of residue and in the rest of the places there is standing residue. In such a case, the performance of the machine decreases and there are germination problems in places where there is moreresidue.

So, it is a prerequisite that the residue should be equally uniform on the field. Now, we can do this equally uniform by employing labor but then we go into labor issues. So to overcome this a new development was done and we call it the SMS i.e. straw manager system. Its job is that when a combine harvester is at work, this works with it and equally distributes the residue on the field in a uniform manner. So this is the calibration and adjustment of the machine where it uniformly distributes the residue.

The second adjustment is that both locks of the PTO shaft should be properly locked.

Third adjustment is that when we place the machine then it should be uniformly balanced. If it is forward leaning or backward leaning, then there will be problems. If it is forward leaning, then these flails will touch to the soil and the soil can get stuck and break. We have to make sure that these should not touch the soil and ideally should remain 4 to 5 cm above the soil. If we raise it more than what was required, then the penetration part of tine will also rise and then either it can get blocked or it won't penetrate. So it is important to have a proper balance.

Depth wheel has a big part to play in adjustment. For different crops there are different depths. First we will talk about wheat. We need 4 to 5 cm depth in wheat. If it is more than that, then our germination and tillers will be affected. For Maize, we can go deeper from 5 to 7 cm. In the case of chickpeas, we can even go 8 to 10 cm deep. So it all depends on the crop. For rice, we only need 2 cm. For Mustard also, the depth has to be low. The depth wheel depends on many things and the same depth cannot apply for every field. The same depth on a moist field will seed deeper because the tine will go deeper as the soil is moist. So, we have to adjust for that. So, field to field depth is important and the same depth cannot be applied to every field.

Now, we come to calibration. We can do adjustment with this and it has values written. But it is not necessary that what is written is correct. We should double confirm it. Suppose if we want to

add 40 kg seeds in 1 acre then how do we do it? We can do two types of calibration, one in the lab and the other on the field. We always prefer field calibration as it is more precise. We put seed and fertilizers in it

There are pipes which we remove and tie a polythene over them. We drive the machine for 30 metres or 50 metres. Collect them again. Now we should know how manytines we have on your machine. So, if we have nine tines and the distance between them is 20cm i.e. the distance between lines. Then 9 multiplied by 20 equals 180. So, 180 cm or 1.8 metreis the width. Then, we multiply 50 into 1.80 and from this we can calculate how much seed is required. If this much was required in one metre then in an acre there are 4000 square meter and we can know how much total seeds, we require for that. So this is the way we do calibration and if once we can do this calibration for a crop then we can make a mark and suggest other farmers about the quantity needed of a particular seed and also do the same for other crops.

Now, we look into the maintenance. If we want our machine to work longer then its maintenance is very important. We know this machine is power operated and a lot of its parts like bearings and gears rotate. So what should we do for its maintenance? First we have to check if the gearbox has gear oil or not. All the bearings and gears should be well greased. These springs have to be properly in place and see if it has got any rust or not. We have to also see if the belt is not too tight or loose and then adjust it accordingly.

Another important point is that after using any machine for an entire season we have to properly wash and clean the fertilizer and seed box otherwise the residue fertilizer can rust the box and then we cannot use it in the next season. We also wash all the flails and tine after the season is over so that there is no rust and blockage.

So these are the main points that we should keep in mind for the maintenance of our machine. Thank you.

So we just looked at the detailed explanation of the machine on the field and learnt about its various parts. Now we will show how this machine works on the field. Before doing anything we first check if all the parts are working properly. Even after doing this, we first try it out in one or two lines just to check how our seeds and fertilizers are falling and what is its pattern and depth. Once we are sure with the pattern, depth, continuation and if the seed rate is according to what we had calibrated then we can run it on the field. If we still face any problem in the field like if there is any residue drag, or any loose machine part then we should stop and fix it. This machine can work from 8 in the morning to 8 at night. But at times if the rice is cut and there is early morning dew then it can face problems. Now the new models have flails that are zig zag so we do not face problems regarding residue but still we prefer to avoid using this machine in the first two hours of the morning. This machine can cover 10 to 15 hectares if it works for 10 hours in a day. Its cost to the farmer is 1000 rupees per acre or 2500 rupees per hectare.

So we have discussed the differences between a happy seeder and zero tillage multi crop planter. Both these machines are used in zero tillage but the normal zero tillage planter cannot what work where there is anchored or loose residue as the tines drag the residue and after covering just 2 to 5 metres then the seed and residue do not drop properly and instead get dragged with the residue.

The machine also gets choked and it becomes very difficult to operate the tractor. So to overcome this problem we developed the Happy seeder. The benefits of happy seeder over the zero tillage multi crop planter is that it can work on any type of field be it a normal zero tillage field or combined harvested field with lots of residue. It has many advantages. With zero tillage multi crop planter either we have to remove or burn the residue or cut it to a very short height. But with a happy seeder, we can keep all the residue inside the field and turn it into fertilizer and do direct sowing. Zero tillage multi crop planter can be used with many crops and the Happy seeder can also work with many different crops provided it has a multi crop seeding device attached to it known as an inclined box.

So we learnt about various aspects of this machine and its different advantages, operations and quality. Taking all these into consideration, this machine will be highly beneficial to the farmer. It will help to increase their yield, clean our environment and help with the water table and soil health.

Thank you.

Course Name: Conservation Agriculture based Sustainable Intensification

Week 02-Lecture-4: Laser Land Leveler

Course Instructor: Dr. Mahesh K. Gathala, Sr. Systems Agronomist, CIMMYT, Bangladesh

Namaste friends
Today, we are going to learn about laser land leveler. It is an automated laser guided beam operated machine that laser levels the outfield in a highly precise manner. It has three components which you can see on the graph. The first one is a transmitter which emits rays. The second one is laser eyes which receive these rays and from where it goes to the control box which in turn sends the signals to the hydraulic system in order for the scrapper to work. We will look into these things in greater detail when we demonstrate it on the field.

Namaste friends, today we are going to explain to you about a very important machine which plays an important role in agriculture as it saves water, increases input use efficiency and overall productivity and quality of crops. This is called laser land leveler and the local name for this is "Computer Manjha". We will look into things like from where did this machine come, what does it do on the field, what is its contribution in agriculture and how does this work. Before going to these things, we would like to go in the past of this machine and learn about its history.

When we are on the field then even if our field is well levelled, it appears as if it is levelled despite having 10 cm to 15 cm of difference of elevation. Now if you give water to an unlevelled field having a difference of elevation between 10 cm to 15 cm, then we would have to water at least 15 cm before the patches which are at height of 15 cm begins to get water. This causes the crops to die because of water logging in patches where the land is low and also the nutrients wash away to the lower level patches from high elevation patches. So this causes a lot of variations in crop production from the same field. In some patches we get very good crops and in some other patches the crop production is very low. Even when we do land levelling with the local traditional land leveler, we cannot minimize the difference in elevation to less than 10 cm depending on the size of the field.

This technology was first introduced in 2001 with the help of a rice-wheat consortium. This machine was already present in India and came in 1990 but it was only limited within the confines of a research institute and was being used for research purposes. The first unit that came to India in 2001 came from Pakistan with the help of CIMMYT, IRRI and ICAR. This machine was used for the first time in district Hapur of western Uttar Pradesh on the field of farmer Dr Tyagi.

When this technology was new, it faced a lot of criticism as it was sophisticated and completely computer based technology, so there were doubts about how the farmer would operate it.

Now from 2001 to 2005, this machine did not spread and its numbers increased from one unit to 15 to 20 units. From 2005 to 2010, 1000 units were sold and then from 2010 onwards there was a revolution in its adoption and now at least 50,000 units are now operating at different farmers' fields. There was no government incentive or subsidies between the year 2001 to 2010 on the

laser land leveler machine. This was an innovation for the farmer and they had seen the benefits from this machine like water saving, crop yield and quality increase and inputs efficiency. The most important advantage of using this machine was that the time it took to irrigate the field with a diesel pump had reduced from 10 hours to around 5 hours. So the farmers saw a lot of benefits and cost savings. This was a brief history of laser land leveler.

Now, we will look at what is a laser land leveler. This machine makes its own beam or level and then we move it in circles using a tractor. With a scrub, it scrapes or cuts land from places where it is high and dumps it in places where it is low. This machine works automatically and the operator has to do nothing. It completely levels the field and the maximum variability is 2 cm.

In the beginning, it was imported from the United States and its price was around 4.5 to 5 lacs excluding the tractor. Soon as it became more popular, many manufacturers started producing it like Dashmesh, Trimble, LICA, Land force and now its cost around 2 lakhs to 4 lakh depending on the quality and scraber bucket width and transmitter radiation.

We would now look at its components. It has three very important components. The first one is a transmitter. Transmitter is fixed at any corner of the field and it has a radius of 200 metres to 1600 metres. It is connected to a battery and transmits infrared rays that go up to a radius of 1600metres depending upon the capacity of the transmitter.

Another important component of a laser land leveler is the laser eye receiver. So the transmitter emits the rays and the receiver receives them. These both components make a level or beam between them and get connected.

The third component is a controller. The receiver collects the signals and then sends them to the controller. Controller has two modes, an auto mode and a manual mode. Now, it is in auto mode and it can work automatically on its own. We can also switch to the manual mode if it is cutting more than we want. The controller sends signal to a fourth important component called Hydraulic pump. The Hydraulic pump is connected to the hydraulic system of the tractor. The hydraulic system of the tractor has two pipes one is the outlet and the other is the inlet. From here it gives oil to the hydraulic pump and this controls the scrubber bucket and then the oil goes back. The Hydraulic pump does the job of circulation.

The most important component is the scrubber bucket. This entire thing is called scrubber bucket. As we get the signal from the controller to the hydraulic pump, the pump controls the bucket which in turn collects the soil from high ground and dumps it in lower ground as the tractor is moving in circular direction. There are two tyres behind the hydraulic system. This machine comes in two forms one with a single tyre and the other with two tyres. The single tyre variant vibrates a lot so the perfection required for levelling was not achieved and so these days we have a two tyre variant.

This is the Hydraulic pump and as it comes to the gauze, it controls where it is required to go high, it goes high and if low then it goes low. The bucket can become large or small depending on the horsepower of the tractor. If the horsepower of the tractor is low, then we can take a small bucket and if it is large then we can take a large bucket that would move more soil.

Now, you can see Yashraj standing over there with a survey unit in his hand. It surveys the elevation of the field. Yashraj will explain how this works. If you raise it, it will tell us the level and we will note these and it is done in a zig zag way.

In the entire field, we measure the leveler points in 15 to 20 different spots and take an average to know the average leveling of the field. Then we take the tractor and scraper on the field at the required level and fix the receiver and transmitter beam and set it up on auto mode. Then we have to operate the tractor in a circular form. We should not operate the tractor from corner to corner as this will accumulate a lot of soil and because of which the tractor won't run. During the working demo, you will see that when a lot of soil is accumulated then the tractor cannot move forward. So, we should operate the tractor slowly.

We can fix the level at either macro level or micro level. Once we are done with the macro level then we can move to the micro level which is mainly for fine tuning.

Now let's see how we operate this. The transmitter over there is powered by a battery of 6 volts to 12 volts.

Now, this is powered by the tractor battery and is connected to it through a wire. The controller and the hydraulic pump are also powered by the tractor battery. So all these three parts are powered by the tractor battery. The transmitter can also be run through small cell batteries but they are exhausted very soon.

Now, how will this work in the controller.When it is in auto how we can control it and in the manual mode, Suman will explain how to control it. On doing it up, the hydraulic goes up and to bring it down then we move it down. But once we fix the beam and set it up on auto then we don't have to control it up and down with our hands. But when we first use it on macro level, we do that in auto mode and then we run it on micro level.

The field efficiency of this machine depends on the size of the field and the elevation. The ideal field size for this machine is 2000 square metres to 4000 square metres which comes around 1 acre. So this can level a 1-acre field in 2 to 3 hours depending on the elevation of the field. If the elevation is a lot, then it would take a lot of time but if it is normal elevation then it can do that in 2 to 3 hours. Farmers can hire the services of this machine and the charges are around 600 to 800 rupees per hour.

This is a very sophisticated and computerized machine so it needs high maintenance. We cannot reverse the transmitter as that would disturb its calibration. Secondly when we operate this machine, we have to properly level it with the leveler and then use it or else the angle of the beam or radiation angle will change. Thirdly, when we have finished using the receiver, we have to take the receiver back and keep it safely in the box. We have to keep the hydraulic pump well-oiled and for that the tractor gear oil level should not fall otherwise it can burst and also damage the tractor.

We also have to take the controller back after we have used it as it can be damaged with rust or dust. All the other components like bearings, bushes have to be well oiled and well maintained and when we are not using it then we should cover it or else it can be damaged by dust All these things maintenance is very important.

The operator driving the tractor also has to take safety precautions like using the tractor on dry soil creates a lot of dust. So it is suggested that they use a mask while operating as we have to care for the health of the tractor operator.

Now, we would look at the benefits of laser leveler and why should the farmer adopt this machine. The first is that it increases the crop yield from 5 to 15%. The second benefit is that it saves about 25% to 43% water used for irrigation depending on field to field
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It helps with water productivity from 16 to 60%. It also saves energy of around 24% in the sense that diesel consumption and running time of pump is less.

It improves the nutrient use efficiency by 10 to 15%. It helps increases the income of farmer by16 to 56%

It also reduces CO2 emissions by 11 to 16% as the use of laser leveler reduces diesel consumption for irrigation, tillage and the savings from fertilizers use.

Now we would look at the impact of laser leveler. It was first introduced in the year 2001 on a farmer's field and as you can see in the graph, its units in operation have increased to 45000.

It has covered around 6 million hectares of land in India and is generating almost 350 man-days per person per unit per year of employment. If we can convert the 6 million hectares then it has generated around 40 million man-days employment. It has generated a lot of indirect employment in the form of manufacturing, spare parts and also a lot of skill development has taken place.

This has increased the production by 2 million tonne per year and with 0.5 tonne gain per hectare per year. So this increases food production, employment, water saving, energy saving and increased skill employment. This is a very beneficial technology and in the coming days, this will be looked as a milestone technology and a blessing which has benefited the farmer and our country.

Course Name: Conservation Agriculture based Sustainable Intensification
Week 02-Lecture-5: Allied CASI Machineries
Course Instructor: Dr. Sanjay Kumar, Chairman, Dept. of Extension Education, BAU, Sabour

Friends, this week, we learnt about the different machines we use for sowing and transplanting that fall under CASI. We mainly looked at the use of Happy Seeder, Multi Crop Planter and Paddy transplanter. Now in this class, we would look at the other supporting machines that fall under the purview of CASI. These machines include Combine Harvester with Super Straw Management System, Straw Reaper, Paddy Straw Chopper, Reaper Combiner, Sprayer and Raise Bed Planter.

First, we will look at the Combine Harvester with super straw management system. As its name suggests, it is commonly used for harvesting crops and it can do three operations at the same time. Its first job is to harvest rice. Secondly, it threshes and finally it does winnowingand the farmer directly gets the grain. It has a capacity to harvest 21 to 22 acres per hour. Combine harvester usually had the problem of distributing residue unevenly. To overcome this problem, Punjab Agricultural University, Ludhiana developed the super straw management system which can be attached at the back of Combine Harvester. It evenly distributes the cut straw and thus facilitates the possibility of using other supporting machines that fall under CASI. This is possible as the residues are evenly distributed so machines like multi crop planter or happy seeder do not choke when being operated on such fields and the seed and fertilizers fall at right time and at the correct depth.

Now, we look at Straw Reaper. One of the main shortcomings of the combine harvester was that the residues were unevenly distributed during its operation. The Straw Reaper cuts and chops these stalks in little pieces in one operation and converts them into straws which get stored in a netted trolley. These stored straws can then be used as fodder for livestock. The biggest advantage of a straw reaper is that the straw it prepares is of better quality than the straw from a thresher. Also, we get an extra 50 to 100 kilograms per hectare of extra grain from our farm.

There is another similar machine called Reaper Combiner. Even today, farmers generally harvest their crop using conventional tools like sickle. But this is a very labour intensive method and we know that in today's time, labour is a precious input and we regularly face labour shortage problems. To overcome this, we have a Reaper Combiner machine which cuts our crop and then with a binding device binds our crop in a bundle and discharges it. Its capacity is 1.3 hectare per hour and thus it saves a lot of time. So this machine saves a lot of time under CASI.

Now, we move to Paddy Straw Chopper. This machine chops all the standing remains in the field in one operation be it Rice, Wheat and Maize crop and converts them in small pieces that can be buried in the soil using a machine like Disc Harrow. This buried residue helps with the sustainability of the soil which is also an important objective of CASI after which we can easily use and do sowing with machines like multi crop planter, zero till machine, no till ferti drill and seed cum fertilizer drill.

Rotary Mulcher is a device with which we can use the residue in our farms as mulch. It has knives which vertically rotate and chops the residue into small pieces. So this machine is used in farms as a mulch stock and we know that if we keep mulch in our soil then our soil temperature and water holding capacity remains maintained.

Now we talk about Baler. Usually after using a combine in a farm, the residues are scattered all over the field. With Baler, we can collect the residues at one place and then it produces prepared compact cylindrical and square shape bales. We can use these prepared residues that come out of a baler as fodder for livestock or as a bio fuel and farmers even sell them to the biofuel industry to earn a good income.

Now, we look at a weeder. This device is very important in farming. Weed is a common problem and even under CASI it is a big issue. We can use any machine as a mechanical weeder like Disc Harrow but an important thing to keep in mind is that we can only use weeder if the sowing is done in a line with proper space maintained. Also, this is more useful where the row to row distance of crop is high.

Another device we look at is a Sprayer. It is a machine which uses liquid as a droplet. To use a sprayer some precautions, have to be taken and it also has some advantages. Sprayer is commonly used to spray herbicide, pesticides, fungicide and weedicide and also to spray micronutrients. Its advantages are that it evenly distributes whichever liquid we are spraying. The most commonly used sprayer is a hydraulic sprayer. It has a pumping device which we can always operate with our hands and it has a capacity of 15 litres. This spray is preferred for any kind of blanket application of any liquid. There is another spray that we use and it is called a centrifugal spray. In this, we keep the liquid in the pump and then inject the pump to spray the pesticides. The sprayer nozzle also has an important role to play. The most commonly used nozzles are flat fan nozzle, flat cut nozzle and hollow nozzle. We use the flat fan nozzle to spray pre-emergent herbicide. The hollow cut nozzle is used to spray fungicide and insecticide. As far as the efficiency of an herbicide is concerned, the role of sprayer management system is very important and also the type of nozzle that we are using. The effectiveness of the herbicide is dependent 50% on the herbicide itself and 50% on the way we are operating are spray.

Now let us take a look at the raised bed planter. We will go to Dr. Mahesh as he is going to explain to us about the raise bed planter. In CASI, the raised bed planter is used to make a permanent bed. If we make a raised bed and maintain it for 10 to 15 years then that is called a raised bed planter. Its main function is

If you see it has the same multi crop raise bed planter. We can do direct seeding like for wheat and also precious planting like for maize and vegetables. Its functions are the same as that of multi crop zero tillage planter. The difference is that it has a frame which has two shapers that lifts soil and makes a bed. So as it makes fresh beds, it simultaneously does the sowing as well. The furrow openers and the two pipes containing seeds and fertilizers drop the seeds in the freshly made bed.

This is a water saving technology as water is required only in the furrow and is not required in the surrounding area. We can save 30% - 40% water through this method. The water logging

sensitive crops like Maize, vegetables or potato can die if we do flood irrigation because of anaerobic situation. So for less water requiring crop, we provide water in the furrow and it gets water and the crop remains dry and we get good yield.

This also has more input use efficiency like fertilizers and seeds are only provided on the bed and crops get exactly these things at their place. This also benefits intercultural operations because there is space between crops and we can easily do intercultural operations mechanically. We can operate a tractor on a standing crop or a weeder. So it has a lot of benefits. Because the crops are planted in a row, the crops get good air flow and because of that disease and insects also infest less.

This technology is very useful in vegetables, cereals, legumes and even oil seeds. If we do this permanently then its efficiency increases by 5 to 10% and it saves energy and tilling cost. We would only have to do seeding. This machine is very economical.

Thank you