Conservation Agriculture-based Sustainable Intensification

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COMMONWEALTH OF LEARNING (COL)

Contents

About agMOOCs Courses

Course Introduction

Conservation Agriculture-based Sustainable Intensification (CASI) includes the adoption of zero or minimum tillage, combined with mechanised crop establishment, maintenance of ground cover, crop rotations and diversification and improved nutrition management. CASI based crop management practices improve crop productivity and profitability while reducing energy, water and labour requirements, and greenhouse gas emissions. CASI also contributes to the improvement of soil health and to the improvement of biodiversity and sustainable agricultural ecosystems which lead to improved rural households' livelihoods.

This course deals with portfolios of CASI and machines used for CASI. We will be also dealing with agronomical management, CASI and its challenges and advantages. This course will also cover how start-ups and business models can be created to successfully implement CASI service provision businesses.

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Course Content

- Portfolios of CASI
- Machines for CASI
- Agronomical Management under CASI

- CASI and its challenges
- Advantages of CASI
- Business Models

Course Audience

- Students/Agri-professionals
- Rural Youth/Farmers
- Faculty Members/Agriculture Scientists
- Professionals working in the Department of Agriculture/ Private Institutions
- Entrepreneurs/Start-ups
- NGOs in Agriculture

Outcomes of this Course

- Participants will be able to know about the fundamentals of CASI and its advantages
- Participants will get essential skills related to CASI based farming

PART I
WEEK 1

1-Portfolios of CASI-CASI and its Components

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Transcript

Hello friends.

The topic that we are discussing today is on Conservation Agriculture based Sustainable Intensification or Conservation Agriculture. 'But before we get into the details, I want to take you back hundred years ago to understand its origin.

During 1930 in the United States of America, it was strongly felt that when farmers plow their field massive amount of dust particles were carried out into their cities through dust cyclone/hurricanes which made the lives in the cities extremely discomforting. To resolve this problem, many researches and discussions were carried out. As a result, a conclusion was made that a new farming system without tillage was necessary.

Therefore, CA started in 1930 and it didn't gain popularity till 1950. Between 1930 to 1950, when CA was applied as a piloted research, it garnered many positive results which quickly lead farmers to adopt CA practices. But from 1950 to 1990, there was very little rise- CA was practiced in only 2-million hectare land. From 1990 to 2015, CA was practices in almost 180- million-hectare land with 10-million hectare annually around the world. The places where CA

is practiced the most is Brazil, next is America followed by Australia. In India, we practice CA at 3-million-hectare land in different form.

Now I am going to focus on what is CA.

CA mainly has three principles:

1. Minimum soil disturbance (not more than 30% of soil disturbance)
2. Soil coverage with organic biomass (to mulch soil with the residue of harvest)
3. Crop diversification (to sow different crops using different methods at different times on a rotation in a one-year crop cycle on same piece of land which is also called a crop cycle)

The successful adoption of CA that we mentioned earlier has been in the rainfed areas or the areas where they only harvest one crop in a year. But in South Asia we have a complex farming system because our agriculture is linked with animal farming and fisheries; and also, we follow 2-4 crops in a cycle that include cereals and vegetables and that keeps on changing according to farmers' demand and requirements. So, it is very complicated to apply all three principles of Conservation Agriculture in South Asian region.

For which we go beyond Conservation Agriculture and discuss about Conservation Agriculture based Sustainable Intensification.

Now I want to address some problems in Indian agriculture. To find the source of problems that we are currently facing in Indian agriculture we must go back in time. In 1960 when Green Revolution started, we were successful in increasing productivity which came with a price. We unleashed a lot of problems which can be arranged in two categories: man-made and nature.

Under man-made problems comes monocropping system in which only one type of crop is sown continuously. Second problem is to adopt new crops and cropping system in new location where not fitted with available resources. The third one is residue burning which is becoming a great problem these days. Fourth one is intensive tillage which is to plow field repeatedly that results in

deterioration of the nutrition of soil. And flood irrigation is yet another big problem. So, we have created many more problems.

Another category of problems- natural problems include climate change issues (like flood, cyclones, other variations in climate), abiotic stresses that we are facing these days like drought, flood, salinity, acidity etc. along with biotic stresses like new diseases. And it can get really complicated if we put them together. The impact they have is very devastating- the water level is decreasing; soil health is deteriorating; global warming is increasing; and our produce is getting low.

Now the challenge we face is we need to increase our productivity, sustain it and protect it from climatic stress.

So, what are the solutions to the problems I mentioned earlier? There are many solutions but the best one is the Conservation Agriculture based Sustainable Intensification.

Conservation Agriculture based Sustainable Intensification is broader than Conservation Agriculture and goes beyond. Conservation Agriculture only deals with tillage, residue and crop diversification but the components of Conservation Agriculture based Sustainable Intensification includes Conservation Agriculture practices along with efficient use of external inputs and natural resources. It is economic and viable to farmers, and appropriate to our farming system that addresses our livestock, fish and soil.

This will make our farming system more resilient, save energy for our future generation, create cleaner environment, and bring biodiversity back in our soil and thus in our ecosystem. In addition, it brings more income to the farmers, improve nation's economic condition, improve our livelihood, increase our food security and we get better nutrition.

As mentioned earlier, there has been positive results from Conservation Agriculture based Sustainable Intensification. In past 20 years from our own farm-trials, we have found:

- 5%- 10% increase in production from crop diversification
- 8%- 17% of irrigation water saved

- 26%- 42% labor saved
- 46%- 62% fuel consumption/ energy saved
- 16%- 56% increase in farmers' income
- 11%- 16% reduction in CO2 emission

Dear friends, today we talked briefly on Conservation Agriculture based Sustainable Intensification. We will tell you more on related aspects in upcoming course. Thank you very much.

2-Zero Tillage Technology

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Transcript

As we discussed yesterday on Conservation Agriculture based Sustainable Intensification, it has three principles and one of them is minimum tillage. What is a definition of minimum tillage? Soil surface should not be disturbed more than 30%. Under 30% of soil disturbance depends upon crop to crop, planting to planting, location and environment. Under minimum tillage, there are two categories: one is zero till or no till which includes surface seeding and other is reduced till which includes strip tillage.

We need to remember that reduced till does not mean reducing the times you till or decrease the number of tillage passes. It is more related with less than 30% of soil disturbance. This is the only qualifying criteria under reduced tillage or else it will be regarded as full tillage because these days there are such implements that does everything in one pass, disturbing equal amount of soil as in 10-15 times tillage or more, like rotavator. So, we are not encouraging its use.

Why do we need zero tillage technology in India? Our Rice-Wheat system is applied around 10- million-hectare land in India. But our rice planting is mainly dependent on rain and later wheat is sown. Since we largely depend on rain, the rice plantation usually gets delayed and again, farmers who sow long-duration rice variety

further delay the process. After harvesting rice, wheat needs to be sown and normally it takes 20-25 days for land preparation. Zero till technology was therefore introduces to shorten this period.

Another reason is: because of maximum tillage, farmers' expenses are increasing. Also, since we are carrying out the same Rice- Wheat system, ***Phalaris minor*** in wheat has become a big problem. To get rid of these problems, zero tillage technology was introduced.

Due to this zero-tillage technology, as soon as rice harvests, on the same day we remove the residue and directly sow the wheat. This process saves at least 15-20 days of land preparation and thus, shortens the duration which also increases 15- 20% wheat yield. So, this is the main reason behind the initiation of zero-tillage technology.

With time many improvements have been made to this technology, like happy seeder, zero tillage seed drill, zero-tillage multi-crop planters, strip tillage machine, two-wheel tractor operated zero tillage and strip tillage machines etc. Depending on the location and the type of power required, the zero-tillage technology has been improvised accordingly. So, this is the reason why we need zero-tillage technology.

Now what are the benefits of zero-tillage technology? The first benefit is previously farmers had to till 10-15 times but now the same work is done in one operation. Another benefit is it shortens the planting duration by 15-20 days. Third benefit is it saves minimum 70% of time that farmers used to invest from land preparation till seeding. Thus, saving 70%- 80% of time. It also saves 35l- 45l of diesel per hectare of land. Based on crop system, it reduces 35-40 labor per hectare of land.

It reduces cost of production by INR 6000- INR 10,000 per hectare of land. A farmer can save from INR 4000- INR 5000 per hectare till seeding. It is found that 5%- 10% of irrigation water is saved. Also, the weed problem which was a huge issue in wheat was significantly reduced due to zero-tillage technology. There is a reduction in herbicide consumption as well. It is also found that there is 5%- 10% increase in production. So, farmers net income has

increased by 20%- 40%. Farmers' water productivity which is also referred as per drop- more crop has increased by 10%- 15%.

Now you may be curious to know if this zero-tillage technology can be used in all crops, cropping systems and location. Yes, it can be used everywhere. We have studied that it is suitable for all cropping systems like Rice- Wheat, Rice- Maize, Maize- Wheat, Rice- Pulses, Cereal- Pulses etc. The only thing that we need to keep in mind is that the seeding mechanism should be fitted according to the crop for which we need to modify the machine as per the requirement. Otherwise, this technology can be used for every crop. Besides, this technology can be used in other crops as well like cereals, legumes, oil seeds, even tuber crops and vegetables.

However, to maintain this technology is not possible for some crop rotation or crops, like tuber crop and potatoes and root vegetable crops like radish, carrot etc. This technology can be used for seeding but to harvest these crops one must disturb the soil. This is the only limitation otherwise there is no problem in seeding using this technology. Apart from this, this technology is very location specific. This technology requires proper adjustments according to location, crop, soil type and environment.

Thank you.

3-Crop Residue Retention

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Transcript

We are discussing about another component of CASI which is residue retention. What is residue retention? Before getting into the topic, we must understand how crop biomass can be managed? There are different methods like crop residue which is left in the field; crop removal which is taken out of the field; third one is crop incorporation which is mixed with the soil in the same field; and the fourth one is crop burning in which farmers usually burn the residue in the field which causes environmental pollution. Among all these methods, the most beneficial one is crop retention.

We can also opt for crop incorporation, but this method consumes a lot of energy and the field needs to be tilled several times. This is a very difficult, time consuming and expensive process for farmers. Now what is crop retention? When we harvest crop, generally Combiner is used. These days SMS (Straw Manager System) is attached to the Combines which helps in equal distribution and forms a mulch in the field. We do not disturb that mulch rather continue seeding in to the mulch. This retention of the mulch is called crop retention.

As mentioned, there are different methods of residue retention and we need to understand its importance. If we take 1 ton of residue, we can find 5.5 kg of nitrogen, 25 kg of potassium, 2.5

kg of Phosphorus, 1.2 kg of Sulphur, 70%- 80% of micronutrients that can absorb and around 400 kg of carbon. When we burn the residue, the nutrients are lost and so, the soil is deteriorated. And if we incorporate it, usually nitrogen and carbon get mineralized and decomposed during the process and the nutrients are lost in form of gases. So, in retaining the residue we get maximum benefit from all the plant nutrients.

Now we deal with comparative advantages of crop residue retention. The first advantage is it increases the organic carbon of soil and catalyzes the secretion of carbon. The second benefit is it improves soil fertility and releases nutrients. It also improves structure of soil and helps in soil aggregation. Besides, permeability of soil or infiltration- an ability to absorb water, increases. This consequently increases the recharge and improves water-holding capability.

It's been found that if we mulch, the moisture in soil is conserved and soil temperature remains balanced. In extreme cold, mulch keeps the temperature of soil from dropping. And in extreme heat, it keeps the temperature of soil cooler by 3- 4 degrees. Overall, it moderates soil temperature and balances by 5- degrees due to which microbial properties increases.

If we mulch the entire season, the conservation of soil moisture remains highest throughout. We have measured it as you can see clearly in the graph, where there is residue, there is less soil tension and vice versa.

With residue retention, the relation between soil, plant and water also improves. This also boosts up plants' physiological activities like increase in photosynthesis, balance in canopy temperature, better respiration etc. So overall, plants get healthier. Mulching also controls decomposition and mineralization of nutrients in the soil. The nutrients are released gradually throughout the season which helps plants to prosper across the season.

One of the benefits that we are losing in conventional agriculture is soil biodiversity. When we mulch, organic matter is decomposing in the soil due to which soil bacterial, fungal, actinomycetes and

overall the population of micro- fauna and macro-fauna, overall soil microbial properties improve. This will improve soil health and hence, rises soil quality index. The overall improvement in soil brought by residue retention improves soil's health which will result in healthier plants, healthier produce and nutritious diet. These are the benefits of residue retention which plays very important role in making soil healthy

4-Crop Diversification and Intensification

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Transcript

Now we will talk about the third principle of CASI i.e. Crop Diversification and Intensification. So what is Crop Diversification and Intensification? The way we know this is, crop diversification is to alternatively sow different crops in a sequence in the same piece of land in the same year to next year. And crop intensification is that instead of doing one crop, we do two crops and instead of two crops we do three crops in a sequence in same year. These depend mainly on 4 or 5 things. The first is that if our cropping system is less profitable and unsustainable then we can turn it to more efficient, profitable and sustainable. This is the first principal – Less profitable to high profitable with more sustainability.

Now, we look at the second principle. If our cropping system is very water loving i.e. requires a lot of water, then we can replace it with a less water loving crop within the same system i.e. one that requires less water and optimizes it. We call it the "more water loving to efficient water loving cropping system". We look at the third principle. In some cropping systems, we keep repeating the same crop and extract more and more yield and biomass. This causes high nutrient uptake. So instead of practicing a high nutrient uptake, if we move towards optimum and efficient nutrient uptake cropping system then we can increase our sustainability.

The last one is that if we keep repeating the same type of crop then it increases the biotic stresses like diseases, insects and these carry forward. So to break this, we move towards a less biotic stresses with changing cropping system. This is our biotic stresses based cropping system and crop diversification. So these were the principles of Crop diversification. Now we look at the advantages of cropping systems. What are the benefits and advantages of it?

The first benefit is how we can increase the income of small and medium scale farmers.

If we do crop diversification and adopt a more cost effective or less requirement crop, then the income of farmers can increase The second point is that if we keep repeating the same crop like in Punjab and Haryana, rice and wheat are very popular. This has an effect on the prices and the government is unable to buy and the prices fall. Instead of just doing rice and wheat, if we diversify into legumes and oil seeds, then the prices of agriculture commodities will be maintained and they won't fluctuate. The third point is that some cropping systems are very sensitive to the climate. If we adopt the one crop cycle, then it is more prone to climatic shocks. If we diversify the cropping system, then the cropping system becomes more resilient to climatic shocks. Like if our one crop gets damaged, then we can profit from the next crop. We also have a mixed crop where if one crop fails, the other is saved. If we add a third crop then farmers can benefit from at least two crops in case, if one gets damaged. So due to crop diversification, the climatic resilience increases.

Now the biggest benefit is that if we just grow rice then we would only eat rice and the same is true for wheat. But, if we grow different crops in our farm then at least our diet will be balanced and our nutrient intake will be better. If we grow different crops like rice, legumes, oil seeds or vegetables and adopt them in our food then we fulfill a balanced diet and food security requirement.

Besides this, our livestock is also dependent on our cropping system. Not just livestock but also our fisheries and dairy is also dependent on our cropping system. All these things are dependent

on the cropping system. If we keep growing the same crop like rice or wheat or any other crop, then we won't find nutritious fodder for our livestock. If we grow different types of crops, then the quality of fodder for our livestock will improve and this can increase our livestock production.

We know the most important subject is natural resources. We have seen how in Punjab, Haryana, the whole of Northwest India and in southern states like Maharashtra, there is a problem of groundwater depletion and one of the reasons for it is our cropping cycle. Like in Punjab and Haryana because of rice and wheat cultivation, our groundwater table is falling down more and more. One day it will finish. Keeping this in mind, if we can adopt an efficient cropping system where we replace rice in the rice-wheat cropping system with maize, sorghum, legumes, oils or soybean then we can save the water table and also increase the farm income. So we can save a very important natural resource and at the same time also improve our air quality. With single cropping cycle, we are using more and more fertilizers and pesticides because the biological stresses are increasing. This contaminates the groundwater and also pollutes our air quality. With diversification, we can improve on these things.

If we do crop diversification in a proper way, then our environment pollution especially air quality like residual burning can improve. Instead of rice, if we bring in another crop then we don't have to burn the crop residue and we can use the residue for other things. Like legume crop does not have a big biomass and it decomposes quickly in case we want to keep it in the farm. Also, if we add a third crop in the rice-wheat cropping cycle like Moongbean, then the deterioration of soil is restored as it is a legume crop and there is nitrogen fixation and its residual increases soil quality and structure.

Now, our use of farm or external inputslike fertilizer, seeds, pesticides and agro chemicals would decrease if we adopt proper and optimum cropping cycle of crop diversification. For example, if we grow legumes or oilseeds after rice then its consumption

will decrease as some crops have Allelopathic effects as they break the cycle of diseases and insects and are able to control pests. This is why we see some weeds that are particularly associated with specific cropping systems. Like in the rice-wheat system, we have *Phalaris minor* and particularly in rice, we have *Echinochlovaspp.*. If we keep following the same system, then the seed bank of these weeds keep increasing in the soil and the problem increases. But if we replace rice-wheat with rice legume or oil seed or vegetable, then we can exhaust the weed seed bank and subsequently can control the weed population. This is true for diseases as well. The carry forward diseases which have its **inoculum and spores** stayed in the soil, we can break its cycle. So we can control the disease, weed and pest population and benefit from it.

Lastly, we can increase the community of food. Like if we keep growing rice after rice, we are increasing our problems but if we diversify our crop then there would be no storage problem and we would also get better quality food and we will have food security. So these are the benefits of Crop diversification and we should adopt it and these are very useful.

Now, we look at the linkage of Crop diversification with CASI (Conservation Agriculture Systems Innovation Center). Crop diversification is an integral part and principle of CASI. If we add all the three aspects of CASI like Zero Tillage technology, residue and crop diversification then the overall holistic benefits we derive out of this will have a large scale impact on soil, environment, system, crop productivity and natural resources and farmers will benefit immensely. So we looked at the three principles and its different components.

The end

5-Practical Issues in Promotion of CASI

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Transcript

Hello Friends! During this week, you got to know about Conservation Agriculture based Sustainable Intensification, Crop Diversification, Crop Residue Retention and Zero Tillage Technology. Since 2014, we are promoting conservation agriculture under SRFSI project in India, Nepal and Bangladesh. We faced a number of challenges during the promotion of conservation agriculture. Today, I will discuss about the key challenges we have faced during the promotion of conservation agriculture and how can we deal with them? Friends, when we talk about challenges, according to me an individual (farmer) is more important than a technology. Especially, perception and mood of a farmer is very important for technology adoption. A farmer who is sowing wheat and maize after a number of ploughing since their ancestors and suddenly, you reach there and suggest them to sow without ploughing obviously, it is quite difficult. If we talk about paddy, a farmerdoespuddling and after that they do transplanting. But, you say NO you have to go for mechanical sowing. This happens to be quite challenging. Second important thing is group dynamics. Farmer is not alone, (s)he has his family &neighbourhood and (s)he lives in a village. People who are associated with him also sometimes create hindrance in adoption process. We have an example, in2014

when we were promoting CASI,A lady farmer was ready to adopt CASI technology but her husband stopped in doing so and ploughed farm during night. Therefore, group dynamics is very important. Third important thing in adoption is small land holding. More than 90 per cent farmers of EGP are belonging to small and marginal category. They do not want to take risk. If you would say by spending one rupee you can earn 2 rupee, in such circumstances predicting the situation of loss aversion they do not wish to do so. Next issue is fragmented land, farmers are having small plots therefore it is difficult to use machines. This also causes difficulty for service providers. Next important issue is gender inequalities, especially in EGP male migration rate is quite high and women are managing farms. Although women do farming but farm related decisions are taken only after consulting their husbands. You can convince women through farm demonstration but it is quite difficult to convince their husbands without technology demonstration. It furthercreates hindrance in the adoption process of a technology.

Another important factor is technological issue which affects the adoption process. Here, agronomical issues are quite important. In 2014, when we started promoting conservation agriculture of Maizeat that time there was an establishment problem in maize crop. Then, we saw farmers were sowing seed mixed with fertilizers through machine. Maize seed is very sensitive to fertilizers and which resulted in poor germination. You have to be very careful. If, machine is simply calibrated to 2 cm then fertilizers will be dropped first and then seeds. Definitely, germination of maize crop will be good. Second issue is, if you are using combine harvester, then there will be a heavy straw load in the field. Under this situation Zero Tillage machine will not be suitable, so you have to use happy seeder. If you will not be careful then there will be a poor germination. Moisture level is another critical point for germination. If you will be careful about proper moisture level and improper depth of sowing will also lead to poor germination. Especially in DSR, weed management is very critical; there is a chance of crop

failure if you will not manage weeds. In addition, quality input is another critical factor for success not only in CASI but also for conventional farming.

Third important factor for CASI is weak value chain. Small farmers cannot purchase their own machines,they depend on other service providers. Mostly service providers use to sow their own fields first then they prefer large farmers over small or marginal land holders.Timely access to machines is an issue for small and marginal farmers. Lack of trained driver is another limiting factor for promotion of CASI. Custom hiring centre (CHC) and Service providers are having sufficient trained drivers to handle CASI machines or not, it is also a matter of consideration. There are some critical issues with CASI machines like operation, calibration and maintenance so we need trained drivers to deal with mechanical issues. Unavailability of parts of machineries and maintenance workshop is another importantneed for CASI. In India, CASI machines are being purchased from Punjab state, if any part of the machine got damaged then again we have to purchase it from Punjab. There is no local workshop for the same.

Apart from all these, lack of right information at the right time and lack of awareness are limiting factors due to which promotion of CASI has not reached to the highest level. However, there is another important cause which has affected the promotion of CASI,that is relative advantage. Main focus of farmers aregetting high yield out of any technology. In this particular technology, the cost of cultivation definitely goes down, but the yield gain does not necessaryto go high, it increases by 5-10 percent only. In this technology it is not assured that the production will be drastically increased. Therefore, this becomes a matter of concern. Let's look at its two dimensions; one is farmers' felt need, when farmers feel the need of adopting a technology just after coming to know about it, that is yield. However, CASI has other benefits, in order to bring his technology in practice we need to work on farmers' behaviour change. Like, this technique is time saving, it saves water, energy. It is environment friendly. How can you make the farmers understand

all these facts in an easy way through communication is the biggest challenge.Other than this, we will also have to look at our policy issues. Government gives 50-75 per cent subsidy on purchase of many types of machinery. Most of the times, farmers do not tend to avail subsidy benefits. So we also need to improve our system in such a way that those farmers who are willing to purchase machinery could do so easily. We also need to provide proper training to the extension professionals who are working for promotion of CASI. This is very important. If they will not be properly trained how they can guide the farmers. We need to work on our complete value chain from buying machine to sowing to harvesting and packaging practice, government will also have to take initiative for the same.

Apart from this, as I have previously said women do not have their farms registered on their names. This causes trouble in getting credits from banks. Hence, credit access is also an important dimension of agriculture and sometimes it creates hindrance in adoption of CASI.

So, you will have to consider all these facts. Friends, we talked about the challenges and one more thing I must say, if you tell anyone about this technology, they will not believe you. To convince farmers more and more field demonstration is required. You will have to plan as many field days as you can, call as many farmers as you can and then demonstrate this technology. Only when they will see it, they will believe it. Secondly, to encourage the adoption of CASI you will also be required to ensure the availability of trained drivers and access to machines.

Thank You .

PART II
WEEK 2

1-Machines for CASI-Multi-Crop Zero Tillage Planter

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Transcript

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 release it 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.

2-Mechanical Transplanter

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://opentextbooks.colvee.org/casi/?p=69#oembed-1

Transcript

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.

3-Happy Seeder

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://opentextbooks.colvee.org/casi/?p=71#oembed-1

Transcript

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 ricewheat 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.

4-Laser Land Leveler

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://opentextbooks.colvee.org/casi/?p=73#oembed-1

Transcript

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 boxwhich 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 welloiled 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 . 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.

5-Allied CASI Machineries

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://opentextbooks.colvee.org/casi/?p=75#oembed-1

Transcript

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

PART III
WEEK 3

1-Agronomical Management under CASI-Land Preparation

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://opentextbooks.colvee.org/casi/?p=88#oembed-1

Transcript

We start the third week of CASI course by looking at how land preparation is done for CASI and what type of soil type we need. We would also be looking at the prerequisites of zero tillage technology.

By land preparation we mean preparing a suitable environment for the plant. This includes weed control and nutrient management in order to prevent soil deficiency. To do proper soil management, we take care of the following things.

First of all, we should completely know the properties of the soil, what is the soil type and the particle density of the soil in which we are going to practice conservation agriculture. We should minimize the use of tillage and have the right amount of organic carbon in the soil. We need to provide such an environment to the soil so that flora and fauna develops in the right way.

Under CASI, as part of land preparation, we practice minimum tillage. By harrowing, we break big lumps of soil into smaller ones and also laser level the land.

In the previous classes we had explained how laser levelling works. It is a machine by which we flatten the level of our agriculture land. It reduces the amount of water needed for

irrigation by 30% and reduces labor cost by 25 – 30%. It also helps in weed control which is an important requirement of CASI. The pesticide or herbicide is evenly applied to the crops and thus increasing its efficiency. Basically, laser levelling prevents over flooding during irrigation and saves labor and increases our productivity by 25 – 30%.

Now, we look at the type of soil needed for CASI. Usually for DSR, we choose a land where there is no water logging. During land preparation, we have to keep in mind that the moisture in the soil should be within the field capacity level. We can do DSR if the field capacity of the soil is say less than 50%. This is possible as under zero technology, we do not have to till the land. We do minimum tilling and then just drop the seed and fertilizer.

In lowland farms where there is possibility of water logging, we first examine the condition of the land by walking on it. If the soil sticks to our feet then we wait for sowing and can use the zero tillage machine or any other machine only after the soil stops clinging to our feet when walking.

If our farm is sloppy or undulating land, then we have to make sure that our work is done across the slope. Even after using the laser leveler on a sloppy land, we should do the work across the slope.

Now, we look at the prerequisites of zero tillage farming. The most important thing for zero tillage is that our land must be laser levelled before we can use the zero tillage technique in our farm. We have already looked at the benefits of laser land levelling like labor and energy savings and productivity increases.

Another prerequisite for zero tillage technology is that we should retain the residue in our farm. It is advised to retain at least 25 – 30 % residue in our soil. This reduces the erosion of soil in our farm and saves the soil from loo and frost. This not just leads to an increase in soil efficiency and utilization but also increases the soil micro flora and fauna and organic carbon. It overall improves the health of the soil.

Another prerequisite for zero tillage is that we know in today's

time a lot of machinery is used in farming. We had earlier looked at the use of combined harvester. So whenever a combined harvester is used, we have to use a baler or straw chopper after that.

Doing these things has numerous benefits. Zero Tillage not only saves labor but also reduces our energy requirement by 70 to 80%. It also increases the crop duration for the next crop. This is very advantageous for our wheat crop as the more time the wheat crop gets, the more its yield increases.

So if we use zero tillage in the rice-wheat cropping system then our rice matures seven days in advance and this gives more time to the wheat crop. If we use zero tillage in CASI then not only it is environmentally friendly but it also increases our yield and productivity.

Zero tillage saves our environment as it reduces the emission of greenhouse gases and helps with carbon sequestration. With more carbon sequestration, the carbon content in our soil increases and ultimately it improves the soil health and fertility.

Laser land levelling and residue retention are two important prerequisites for zero tillage.

Also, in order to do good agriculture management practice, we have to keep a record of our activities like how much tilling did we do, how did we do sowing and what is the amount of residue retention. We have to maintain a crop friendly environment in the soil and stop soil compactness and maintain soil environment in such a way that there is more and more micro fauna and flora in the soil,

So for land preparation under CASI, we need to know how to do soil preparation and how to manage it so that we can get the most benefit.

Download

PDF: Land Preparation

2-Herbicides Application

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Transcript

Friends, now we are at the second lesson of the third week of our course about CASI. In this lesson we will cover why we use herbicide under CASI and what are the different types and applications of herbicides. We would also look at the use of the nozzle and what are the precautions that need to be taken while using herbicide.

Firstly, we look at why we need herbicide under CASI. We already know that one of the principles of CASI is that we need to do minimum tilling of our farm. We also know the benefits of CASI that it improves the quality of soil and it increases the water holding capacity and fertility of soil.

We know that when we practice zero tillage then there is an increase in weed growth. As we are not tilling the soil so we cannot get rid of the weeds. Hence the role of herbicide becomes very important.

Under CASI, minimum tillage is a requirement and if we do not use herbicide then we would have to employ manual labor at least 2 or 3 times to manage weed. This would increase our cost of production. In such scenarios, we use the medium of herbicide to control our weed growth.

In conservation agriculture we work in system mode. Now under system mode we have to take special care of herbicide and how

we use it so that we can maximize our benefit. If we practice conservation agriculture without the use of herbicide, then we cannot achieve the final objective of conservation agriculture i.e. not just increase productivity but also generate income in a sustainable way and increase the benefit cost ratio. So not using herbicide in conservation agriculture will result in increased farming expenses and also increase our labor requirements which is a very costly input in today's time.

Now we look at the different types of herbicide in terms of their effects. First we look at pre plant herbicide. We use **glyphosate** and **paraquat** when we are practicing zero tilling under conservation agriculture. Although, **glyphosate** is now thought to be carcinogenic. But still even today for preplant application we consider **glyphosate** and **paraquat** the best means of weed control. We control weed at the start of farming so that later it becomes easy to manage our farm.

The second herbicide is called contact herbicide. This herbicide slowly kills any plant that it touches.

The third herbicide is called the selective herbicide and it goes into the system of the plant and stops its growth and ultimately kills the plant.

In terms of selectivity, herbicide is of two types – selective and non- selective.

In terms of selectivity, herbicides of two types selective and nonselective. The selective herbicide commonly attacks only the target plant and leaves alone our main crop. On the other hand, the nonselective herbicide, once sprayed kills all the plants that are in the farm.

Now in terms of state, herbicides are of several types. Some are in liquid form and others are in **emulsified concentrate etc.**

In terms of applications, herbicides are divided into three kinds. The first is pre emergence herbicide and these are used within 3 days of sowing. This includes **pendimethalin** which is its best example.

The second is post-emergent herbicide and these are used when

and plant starts growing. These have particular date of application like **2 4-D** is used within 30 to 40 days in wheat crop. In maize, **laudis** is used within 15 to 25 days.

There is another herbicide known as pre-plant herbicide and it is used to kill annual weeds in conservation agriculture. **Paraquat** is an example of such a herbicide.

Now we look at nozzles. In the last class we had looked at flat fan nozzle and hollow cut nozzle. We use flat fan nozzle for the application of pre and post emergent herbicide.

Now, for the maintenance of nozzle, it is always suggested not to use any nails. We clean it using a high stream of water.

Now we discuss the calibration of the spray. If we calibrate the spray correctly, then we can use the right amount of herbicide. Three factors are important while calibrating. These are the speed of the person spraying, the capacity of the nozzle and the pressure within the spray. For the right output we have to move at the correct speed. If our speed is more than the normal speed, then our output would decrease per hectare. If the speed is correct then our output is ideal. Now, if the nozzle is outputting more liquid then required than our output will decrease per hectare. Also if there is more pressure in the sprayer machine then our output would decrease.

So for calibration, we keep in mind three things – the speed of the spraying person, the flow rate of nozzle and the pressure of the spraying machine. If the speed of spraying person is more than our output decreases and if the speed of spraying person is less than our output increases.

If the flow rate of nozzle is more than our output per hectare would be more.

Similarly, if we slightly increase the pressure of the spraying machine then there would be a similar increase in our output per hectare.

So if we change the speed, the flow of nozzle and the pressure of spraying machine then we should recalibrate the spraying machine

Now we talk about the precautions we should take while spraying. We should always make sure that the spraying person is covering his

body. While spraying we should be careful that none of the spraying particles comes into contact with the eye and skin of the spraying person. He should wear a full length boot while spraying and always wash his hands with soap after spraying. Also, he should not eat anything or smoke while spraying. These are the guidelines that one should follow while spraying and thus save ourselves from the dangers of spraying herbicide.

Download

PDF: Herbicides Application

3-Weed Management for ZT Crops

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Transcript

Today, we look at the third lesson of this week of our CASI course. In this lesson, we will take a look how to control the growth of weeds in our major crops.

First, we understand what weeds are. Weed is a biological hurdle that not only affects crop production but also its quality. Data has shown that we lose around 30 to 35% of production due to weeds. In terms of season, this loss in crop production is around 25% during Rabi season and 35 to 37% during the Kharif season as there is plenty of moisture during Kharif time.

Now, we look at the various techniques to control the growth of weed. The first technique to control the growth of weed is called ploughing technique. Under this technique, we do deep ploughing of our field in order to control weed growth. But this technique cannot come under conservation agriculture as one of the requirements of conservation agriculture is minimum tillage.

The second technique to control weed growth is choosing a crop that is more resistant to the growth of weeds. These crops are usually those whose initial development or growth is very fast and thus it is able to suppress the growth of weed and thereby control the weeds.

Another technique is the solarization of soil. We do this by

covering our field with a plastic sheet so that the temperature of the soil increases and this comparatively reduces the growth of weeds. Mulching is another technique to control the growth of weeds. We know that under conservation agriculture, through residue management, we increase the water holding capacity of soil and control the growth of weeds. When there is mulch on the field then it prevents natural resources from getting to the weeds like unideal temperature for weeds and thus suppress their growth.

Now, through **manual weeding** we can control weed but it also increases our labor cost. This goes against the conservation agriculture principle of sustaining soil while keeping labor cost low. So that is why we give importance to controlling weed through the use of chemicals in conservation agriculture.

There are three types of weeds. The first is **narrow leaf** weed and these are mainly monocot. The second is wide leaf weed and these include **Anagalis**. The most common **grassy** weed is doob and it can be found in every season. In **sedges** weeds, **motha** is the most problematic.

Now, we move towards the discussion of rice. Rice is grown using both transplanting rice technique and direct seeding rice technique. In DSR, for weed control, first we apply pre emergence herbicide. Pendimethalin and **pyrazosulphoron** are commonly used as pre emergence herbicide. You can see on the slide, the various herbicides used and their quantities. Bispyribac sodium is used to control broad leaf weed and narrow leaf weed in both DSR rice and transplanted rice. Under SRFSI project, when we used Bispyribac sodium and **pyrazosulphoron** as post emergent herbicide to control weed, it increased our productivity and also had the highest weed control efficiency.

So besides Bispyribac sodium and **pyrazosulphoron** herbicide, we also use Several other herbicides that are shown in the slide to control weeds in rice.

Now, we look at wheat. In rabi crop, the growth of weed is less compared to the kharif crops and thus it is easier to do weed management through chemicals.

In rice, we use Pendimethalin as a pre-emergence herbicide and is used within 72 hours of sowing. It is always suggested the field should be moist before applying pre-emergence herbicide and we always backward spray it.

To control narrow leaf weed, we use Clodinafop or Isoproturon herbicide and for broadleaf weed, the best herbicide to use is 2,4-D Ethyl Ester. We can also use some new herbicides like Sulfosulfuron in place of 2,4-D Ethyl Ester. Sulfosulfuron is an easy to use herbicide and is also used in less quantity. If both monocot and dicot weeds are present in the field, then we can prepare and use a tank mix spray solution of both broadleaf and narrow leaf herbicides.

Now we look at maize which is another important crop. It is mainly grown as a rabi crop. Under SFRSI experiment, the best option we found for weed control in maize was to use Pendimethalin as pre emergence herbicide and use Atrazine and Tembotrione as early post emergence herbicide. So using both Atrazine and Tembotrione, our production and productivity increased and our weed control efficiency improved.

Now, we look at pulses. Most pulses crop are **dicot**. Now in **dicot crop**, it is very difficult to control broadleaf weed in post emergence. For pulses, we suggest Pendimethalin for pre-emergence weed control. For post emergence herbicide, we use Quizalofop for narrow leaf weeds and use Imazethapyr for kharif crop. We use 400 to 600 ml in one hectare to control all kinds of weeds. At times, we see some side effects with the use of Imazethapyr as it temporarily stops plant growth for some time.

As far as oilseeds are concerned, we use Pendimethalin as pre-emergence herbicide and we use imazethapyr and **imazamox** as post emergent herbicide for crops like groundnut and soybean. We use 600 to 800 ml of Imazethapyr and **imazamox** per hectare for groundnut and soybean.

So using chemical fertilizers not only saves our time but it also saves labor cost and this increases our productivity and maximizes our profit.

Download

PDF: Weed Management for ZT Crops

4-Nutrient Management

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Transcript

Friends, we are in the third week of our CASI course and now we will look at the nutrient management of soil. We already know that plant growth is not possible without nutrients. We define nutrients as those elements without which plants cannot grow completely. We can overcome the deficiency of these nutrient elements only through the use of these elements. These nutrients take part in the metabolism of the plant and also aid in their development.

We already know that plants need 17 nutrients for its growth. Out of these 17 nutrients, carbon, hydrogen and oxygen are available in the environment. We divide the rest of nutrients into two types; major elements and micro elements.

The nutrients that come under major elements include nitrogen, phosphorus, potash, calcium, magnesium and Sulphur. Micro nutrients include copper, iron, manganese, molybdenum, boron and others. We call them major and minor elements because plants require major elements more than the minor elements.

Now, we will look at why nutrients are important for a plant and what are the symptoms of its deficiency.

Nitrogen is important for plants as it gives greenness to the plants and aids in its growth. Before talking about the deficiency of nutrients and plants, we will discuss the mobility of nutrients.

The elements within a plant are either mobile or immobile. The major elements within a plant are nitrogen, phosphorus and potash and they are considered mobile. A common way of finding deficiency symptoms within a plant are by looking at the greenness of the leaves. The mobile elements within a plant can move quickly. So their deficiency is more common in older leaves. The deficiency of immovable elements is more common in new leaves.

Now let us talk about nitrogen. Due to nitrogen deficiency, the leaves of a plant turn yellow and their yellowness keeps increasing as long as the nitrogen deficiency persists. As a result, these leaves fall and this affects the plant.

Now, phosphorus deficiency is the opposite of nitrogen deficiency. In phosphorus deficiency, the leaves turn deep green as compared to yellow in nitrogen deficiency. As the leaves turn deep green due to phosphorus deficiency, a purple tint appears in the leaves and this purple tint sometimes appears in the stalk of the plant.

In Potash deficiency, the plant turns yellow especially in the margins and tip. If the deficiency continues then eventually the plant dries up.

Sometimes due to phosphorus deficiency, the growth of plants increases suddenly but at the same time they become weak and eventually fall down.

So these were the deficiency of three major elements. Similar to these is the deficiency of Sulphur and its deficiency symptoms are very similar to the deficiency symptoms of nitrogen. But Sulphur deficiency first appears in the new leaves as compared to nitrogen deficiency which first appears on older leaves.

Now we will look at some decision tools through which we can meet the nitrogen needs in plants.

The first is the leaf color chart which is a scale that has 5 or 6 green color strips. These strips go from yellowish green to deep green. Now when we go to our farm, we compare the color of the leaves with this chart. If out of 10 leaves, 6 leaves appear slightly

yellow and the greenness of these leaves are less than number 4 on the color chart then we provide per acre 25 kg nitrogen to the farm.

Normally, to identify the nitrogen status in the plants, we repeatedly use the leaf color chart at specific intervals be it a period of 7 to 14 days.

We usually do this till 14 days after sowing but we stop using the leaf color chart after flowering.

This helps us to avoid excess use of nitrogen and increases the usage efficiency of nitrogen and crop productivity.

Green seeker is another decision tool. It is a sensor based equipment that is used to help effectively and precisely to manage crop inputs. We can know the health of the plant through the Green Seeker. There is a sensor fitted at the bottom with a trigger. When we pull the trigger and go to the row of the plant, it keeps giving us a reading for as long as we have pulled the trigger. The reading is measured in terms of NDVI and ranges from 0.00 to 0.99 with a higher NDVI value signifying better health of the plant.

The Green seeker helps us to prevent excess use of nitrogen. We are able to provide the right amount of nitrogen which is required by the plant. We can also connect the green seeker with a smartphone and through an app calculate the nitrogen requirement.

Usually, we use the green seeker in places where we do not have soil testing facilities and thus prevent excess use of nitrogen.

Now we look at the crop manager. It is based on 4Rs which means right source of fertilizer, right time of application, right placement and right application. Crop manager is software based and is mostly used in places where we do not have the facility of soil testing or it is very expensive to do soil testing. In crop manager, we use the knowledge of farmers and feed the personalized data of their farms. We fix a crop productivity target and then based on this target we feed the data which gives us a result where it tells us how much nutrient to apply in this crop. This software helps us to prevent the excess use of nitrogen in our farm and we depend on research trials and demonstrations at farmers' fields.

So all these decisions tools help us to prevent the excessive use of nitrogen.This is more important in India's context as nitrogen fertilizer is subsided in the country and the government has to bear a huge economic cost. So if we use all these decision tools like crop manager, green seeker and leaf color chart then we can use fertilizer at the right time, the right form and the right quantity.

Download

PDF: Nutrient Management

5-Water Management

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Transcript

This is the fifth lesson of the third week of our CASI course. In this lesson, we will study irrigation management and its problems. We will look at when to do irrigation management and at what quantity. We will also look at the equipment required for irrigation management and what we can do to increase water efficiency.

First of all, we will talk about water management. As we all know water plays an important role in plant growth and its relating activities. In India only around 40 to 42% of farmland is irrigated while the rest 58 to 60% are rainfed. One of the aims of our prime minister is to double the productivity of our farms and income of farmers by the year 2022. The idea is to grow more food with one drop of water.

When it comes to problems associated with irrigation, we know that farmers don't have enough information to manage water and as a result, a lot of water is lost due to run off. Also, what type of cropping pattern should we practice plays an important role. If we have limited water supply then after rice, we can grow pulses or oilseeds instead of growing wheat. We can do pulses farming in the rabi season in places we have harvested run off water.

Now we look at the advantages of irrigation. If we have irrigation facilities available in our farms, then we can increase our crop

productivity by many times. Also, if we have irrigation water available then we can grow at least three to four crops in a year from our farm. So we can increase our cropping intensity. If we have irrigation resources available, then we can choose to grow those crops that require more water.

Now, how much water we should give to our crops depends on a variety of factors. First we look at our soil structure. Usually, if it is a clay soil then it has more water retention capacity and as such requires less water compared to sandy soil where we have to frequently give irrigation to our farm.

Now, depending on the chemical condition of soil, we can say that high fertile soil requires more water as we can get high yield. Also, the efficiency of fertilizer depends on the availability of water for irrigation.

So basically, fields that are more fertile require a higher amount of water and less fertile fields require comparatively less water.

We also provide water to the field according to the moisture available in the soil. So if the soil is dry then it would require more water for irrigation.

Crop depth also plays a role in the need for water. We select the water requirement according to the kind of root we have like fibrous root or tap root

Water is required by different crops in different quantities. Usually, wheat requires more water than gram and barley. So, we have to provide more irrigation to the wheat crop.

The chemical composition of soil like if the soil is **acidic** or **saline** also plays a role in how much water is required for irrigation.

If soil is more saline, then water required for irrigation will be more.

Now we will look at how we can increase the usage efficiency of water. Under conservation agriculture we know that the use efficiency of water is more in a laser leveled farm. So to increase the use efficiency of water we have to first laser level our field.

Another way to increase the use efficiency of water is to use

drains that are permanent. Farmers usually have drains in their farms that are made of mud.

We can also use short duration crops in places where water availability is less because in short duration crops, we get higher yield compared to the amount of water we have used.

So these are the various methods by which we can increase the use efficiency of water.

Now next, we look at when we should provide water to our farm. There are various agronomic practices that we can employ to find out if our crop needs water or not.

First, we can look at the condition of our crop to find out if our crop requires water. Usually, if the leaves start curling up then we know that the crop needs water and we immediately provide water to it.

We can also employ the feel method to the soil to know if our crops need water or not. Usually we take a small amount of soil and turn it into a round shape ball and if this soil breaks on even a small drop then we know that the soil needs water.

Now in case of a clayey soil, we again make a round shape ball with this soil and if it cracks on pressing it with a thumb then we understand that the soil needs water.

There are also climatological approaches to know if our crop requires water. We use the pan evaporative method to know what the level of water is in our farm and what our soil requires.

Another approach to know if our farm requires water is to employ the use of indicator plants. Usually sunflower and maize plants require more water. We use these as an indicator plant in other crops farming. If the sunflower start curling we understand that this farm needs water and we provide irrigation water to the farm.

Another approach is to determine the water need during the critical stage of the growth of a plant. Critical stage is that stage when a plant requires more water. In case of wheat the crown root initiation stage is considered the most critical stage. This stage comes within 21 to 25 days and it is very important to irrigate our farm. The other critical stages of wheat are jointing and milking.

In the case of rice, panicle initiation stage and flowering stage are considered critical. For the maize crop, the critical stages are the knee high stage and tasseling or silking.

One more way of finding water requirements is to use soil sand mini kit. We put some amount of sand in one metre square patch of our farm and keep the rest of the farm as it is. Now the water holding capacity of sand is very low so we use this small patch as an indicator and whenever water is low in this patch we irrigate our entire farm.

We also use the method of increasing plant population in the farm. We grow around 1.5 to 2 times more plants in one metre square patch of our farm while the rest of the farm has a normal number of crops planted. Usually where there are more plants, the water deficiency will show quickly and we take that as an indicator to irrigate our entire farm.

We also have an instrument called tensiometer with which we can measure the tension in the soil. It has a ceramic cup which we insert in the soil. This is more common in garden crops. It provides us with a reading that ranges from 0 to 100 kilopascals. In case of sandy soil, if tension metre shows reading between 30 to 40 kilopascals then we irrigate the farm. For clayey or heavy soil, we take 60 to 70 kilopascals as an indication to irrigate our farm. If for any soil, the reading of this metre shows above 70 kilopascals then we take that as dry soil.

There are other instruments as well through which we can know the water requirements of our farm. The first is an infrared thermometer and we use it to measure the canopy temperature and then compare it with the air temperature. As long as the canopy temperature is less than the air temperature, we understand that there is the right level of water in the soil.

We also employ the method of remote sensing to know if our field requires water. It is mainly used in big farms with single crop. Infrared rays reflected by well irrigated crops and crops that are in stressed condition give us an idea about the water requirements.

We can also use different irrigation techniques to improve the use

efficiency of water. These days we prefer drip irrigation compared to surface or subsurface irrigation. With drip or sprinkler irrigation we can irrigate more farm area with less amount of water.

Thank you

Download

PDF: Water Management

PART IV

WEEK 4

1-CASI and its Challenges-Crop Residue Management

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://opentextbooks.colvee.org/casi/?p=115#oembed-1

Transcript

Namaste friends. Modern day agriculture has been made easy with the use of agriculture machines and tools. But the use of certain machines has also created some problems. The combine harvester is one such machine as it leaves behind crop residue after harvesting. Now, a lot of farmers are in a hurry to plant the next crop so they burn the crop residues and that creates a lot of problems.

Today, we will talk about crop residue management. India produces around 700 million tons of crop residue. Now, food crops like wheat, rice, maize, bajra, jowar and others contribute around 368 million tons of crop residue which comes around 54% of the overall crop residue produced. Sugarcane produces around 111 million tons of crop residue and this is 16% of the total crop residue generated.

Individually, rice produces around 154 million tons of crop residue, wheat produces 131 million tonss of crop residue. In terms of provinces, Uttar Pradesh contributes the most with 60 million tons of crop residue. Next is Punjab which produces 51 million tons of crop residue and third is Maharashtra which produces 46 million

tons of residues. West Bengal produces 36 million tons and Bihar produces around 30 million tons of crop residue.

Out of the 700 million tons' crop residue produced, around 234 million tons of crop residue is surplus. Individually, rice produces around 43.5 million tons of surplus, wheat contributes 28.4 million tons, sugarcane produces 55.7 million tons and cotton producers around 46.9 million tons of surplus.

The farmers in our country burn around a 100 million tons of crop residue in our farms which creates a lot of problems. As a result of residue burning, greenhouse gases are emitted in the environment. Also, the beneficial microbes in the soil die and we lose soil nutrients. Additionally, there is deterioration of air quality.

Burning around 100 million tons of crop residue produces 8.7 million tons of carbon monoxide, 141.15 million tons of carbon dioxide, 0.037 million ton of Sulphur oxide, 0.23 million tons of nitrous oxide and around 1.21 million tons of particulate matter. Besides these, many other poisonous gases are also produced which pollutes our environment.

Now to manage crop residue, there are many machines available. The foremost advice given to farmers is to attach a straw management system to their combine harvester. The second most helpful machine is a Happy seeder for crop residue management. We can use the Happy seeder machine if there is a lot of crop residue in our farm and it is not possible to use a zero till machine. If the crop was cut properly then after using a baler we can use a Zero Tillage machine.

We can also use a paddy chopper. It cuts the crop and mixes it in the soil. There is another machine called reaper combiner that cuts the crop and then also binds it together. Another machine called mulcher is also a useful machine in crop residue management. There are many additional machines that are available which can facilitate the management of residue in our farm.

Crop residue can be used to produce many different products and has many beneficial uses. In India crop residue is mostly used as a fodder for livestock. But paddy straw has less quantity of crude

protein and also has issues with digestibility. So if we treat the paddy straw with urea, then it increases the quantity of crude protein and its digestibility. For 100 kg of feed, 4 kg of urea is sufficient and we can make our feed useful.

Also, these days using crop residue to produce electricity is being tested. The Punjab government has established four or five such units. But if this is useful or not is still up to debate.

Paddy and Wheat straw is also used for mushroom production. It is said that with 1 kg of residue, we can produce around 1 to1.15 kg oyster mushroom or 700 to 800-gram button mushroom.

We can also use the residue as an inert material in bio fertilizers. Now, mostly talcum powder, charcoal or fly ashis used as an inert material. Charcoal is considered the best material as it has two beneficial traits. The water holding capacity of inert material should be more than 40% and its size should be between 0.15 to 0.21 mm. If these two qualities can be created for crop residue, then we can use this as an inert material for bio fertilizers.

In addition to the above, we can also use crop residue as bio jar. We also use crop residue for mulching in vegetable production. Crop residue was successfully used to produce souvenirs by ladies in Jehanabad and these souvenirs sell for good money. Crop residue can be used in the form of business. Some Delhi based startups have used the crop residue for packaging material and plates. We can also use it in vermicomposting. Finally, in India, ethanol production is being contemplated and how ethanol can be produced using crop residue.

So there are many uses of crop residue and the main thing is that we have to make these options economical.

In the end we now look at the problems in crop residue management. The biggest problem is that if we use a combine harvester without the straw management system then it is very difficult to manage the crop residue. The second problem is the transportation cost of moving crop residue from one place to the other. Crop residue is produced in great volume and it is expensive to transport. Also, the time frame between harvest and sowing the

next crop is small so many times farmers are in a hurry and they decide to burn the residue. Finally, a lot more research needs to be done so that we can make crop residue management and alternate use economical so that farmers can easily adopt it.

In the end, I would say not to burn the crop residue as it can be a very useful value added product and also an additional source of income. By doing this, we also keep our air clean.

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PDF: Crop Residue Management

2-CASI Scaling : A System Approach

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://opentextbooks.colvee.org/casi/?p=117#oembed-1

Transcript

Namaste, friends. If we want farmers to adopt a particular technology, then even a small mistake can hinder its spread.

There can be many reasons for a technology not spreading. We might be a research and development institute and focus solely on technology but due to lack of proper infrastructure, the technology fails to become popular. It can also be that we are a government institute that provides subsidies or financial support or machinery but because of not following proper protocol, the technology fails to spread. Or we might be a donor who is running a research program, then the agency through which we are working has an important role to play.

So the main reason why any technology is not adopted is because we do not look at it as a system approach. CASI is a system approach and its scaling is a system. The different stakeholders like the farmer, government agencies, research and development institutes, donor, private institutions that manufacture machines and service providers should have communication between each other and they should know what role they play and who can play what work efficiently. It is because of lack of communication between the various stakeholders that the adoption of technology is very slow or it does not take place.

To understand it better, we will now discuss the scaling framework and who are the different stakeholders and how we can improve this whole process.

The adoption process is also affected by the socio-economic condition of the farmer, access to resources, gender and his entitlement to land.

Besides this, the decision making process of a farmer is a very complex process. It is simplistic to think that he will adopt the technology by just looking at the economic perspective. The farmer while deciding which technology to adopt keeps in mind the biophysical condition of his farm, his soil, water availability, rainfall pattern and connectivity.

The nature of technology we are offering and the relative advantage that it offers over the technology that is currently in use also plays an important role in a technology adoption. The value offer of this new technology should be better than the current technology in use like it should increase yield or it should lower cost of cultivation.

Next, we also have to consider the scalability and the things that are required for the successful diffusion of a technology. An example can be the lack of infrastructure like in every village there should be at least one machine. But with just one machine, the technology can be adopted only within a limited area. So the adoption process might get halted by the lack of infrastructure.

Now looking at the entire process of diffusion of a technology in a systems perspective, we have to look at the role of different stakeholders. The research and development institute can improve their prototype, capacity development of stakeholders can be improved, the government needs to develop the infrastructure, the donors should support research programs and the private institutions need to provide quality machines and inputs.

All this depends on two factors. The first is how we can make this process effective with least resources. The second is that we have to see what is the right role for whom and according to that we will have to strengthen the convergence process. Once we have created

the system then we would have to institutionalize or formalize it and then it would become stable. We require political and government support to achieve this. So CASI is an agriculture innovation system and the role of place, people and portfolio are very important.

Now, we look at the challenges in the scaling of CASI. In the first week we looked at some practical issues. Now, we will look at other issues. First, many times we do not understand the system and because of that our scaling process goes slow. We have to work in the farming system perspective and identify people's problems and their local situation. We have to work together with the people and move forward the participatory technology development process or demonstrations. The third is technological challenges like because of not having proper protocol we do not get germination or there is a lot of weed infestation or many times there is crop failure as a result of which the trust of farmer breaks and it becomes very difficult.

In conservation agriculture there is also the problem that we do not at times see the results immediately. For example, we say that conservation agriculture will improve our soil health. But for that we have to do crop residue retention for a long time and then we can see the improvement in soil health. So at times a long term perspective can come up as a challenge.

We have to develop convergence and trust between different stakeholders. Many times due to lack of trust, the stakeholders work in different directions and this slows our adoption and scaling process.

Recently, the burning of crop residue has come out to be a major problem. Farmers burn the crop residue in the farm itself as the window from the harvest and sowing of the next crop is very small.

Additionally, there is also the problem of using crop residue as fuel and fodder. So if we are advising farmers to do more and more crop residue retention then we have to understand that crop residue is a valuable product for farmers and they use it as a fodder

for their livestock. So we will have to make a balance between all of these things

Government institutions and political leaders also have a role to play in the scaling process. It is very important that they also have some knowledge of the technology.

In the end, we have to do capacity development of all the stakeholder be it the research and development people, scientist, farmers, service providers or anyone associated with the manufacture of machines. Only then will our system be able to run smoothly. This also can be a major reason why technology is not adopted.

So friends, we have to look at adoption as an overall systems perspective. The moment we see it as an isolated sub system like technology, capacity development or knowledge dissemination then our scaling process does not take place as we want.

So our suggestion is that this is a system and we should look at it from a system perspective.

Download

PDF: CASI Scaling: A System Approach

3-Social-Behavioural Challenges

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://opentextbooks.colvee.org/casi/?p=119#oembed-1

Transcript

Namaste friends. We have so far learnt about the benefits of conservation agriculture like how it is less costly, produces more yield, saves time, water and labor. In addition to these, it is also proven that conservation agriculture is environment friendly.

But a question still remains is that despite being so beneficial, why is conservation agriculture not adopted at the rate it should have been. In a social system, why have we not able to achieve the take off point? By takeoff point we mean that any technology, once it is adopted by around 10% to 15% then this technology need not be pushed. Farmers by themselves communicate with each other and adopt this technique.

Some intriguing question that arouses our interest is that if a farmer has 10 acres of farm then why does he do conservation agriculture only in 2 or 3 acres and not in the entire 10 acres. Also, we are pushing the adoption of conservation agriculture but why are farmers not coming by themselves and asking about conservation agriculture and its adoption.

To answer these questions, we would have to understand the adoption process which is a very complex process. The decision making process of people and their behavior is very complex.

If we look at the adoption process, we see that there is a farmer

who adopts a technology. Now according to Rogers, this technology should have 5 characteristics i.e. relative advantage, complexity, compatibility, trialability and observability.

Also there is the communication channel or change agent through which our technique is reaching the farmers. It is a social system where the farmer is not alone. There are other people who are influencing his decision.

We know that farmers or anyone else take rational decisions on the basis of information and money available to them. This is called the bounded rationality model.

Now today, we will talk about something that is in addition to the above factors. Besides, age and education of the farmer and technology, there are many more components that influence the adoption process.

We are for the first time going to look into behaviour economics in Eastern Gangetic Plains and aim to find answers about why despite technology being beneficial, people are not adopting it at the desired speed.

From our research, we have found that in addition to providing reminders or nudges to someone, we should also organize demonstrations. Farmers always want to see something first and then trust it. So we just don't have to push the technology but also organize demonstrations or trials.

I want to share a real life example. We were working in Purnea district and I asked a farmer who is considered a large cultivator about why he did not adopt this technique when we initially started it. His reply was he first wanted to observe it. The field technician would always tell him to come to the trial demonstration plot but he first wanted to try it in a small area and see the result. After finding it is beneficial, he increased the area. So basically, continuous reminders are very important.

Also, we have to understand that while promoting zero tillage, we are telling farmers in a way to not do something that they have been doing since generations i.e. tilling. So we have to share the message

with farmers in such a way that they can understand us and adopt this new technology.

Farmers live in a social system and are not alone. They have a family with certain social norms and influences.

I want to share another interesting story with you all. On many occasions, we used to organize a focus group discussion with farmers after crop harvest. We would invite farmers who have adopted conservation agriculture and also those who have not adopted it. The farmers who have adopted conservation agriculture would share the benefits of it and then we would ask those farmers who have not adopted conservation agriculture about why they have not tried it as their neighbors are benefitting from it. So under peer pressure, they would say that they would do it from now and eventually they would actually do it. So we can keep these things in mind while designing the adoption or diffusion process.

Now 90% of the farmers in EGP are small cultivators. If due to some reason their crop fails, then their livelihood will be affected. So they are risk / loss averse. If you tell them to invest 1 rupees promising 2 rupees in return, then they still won't do it. They want to keep doing what they are doing as it is well proven. So you have to instill trust in them that your technology is beneficial and that they are not going to incur any loss because of it.

According to us, many times farmers behave irrationally like whenever we talk to farmers about any new technique, the first thing they ask us is how much more yield can it generate. Seldom, we meet farmers who take into consideration their cost of cultivation. With this technology, we can only get 5to 10 % better yield but there is a lot of cost savings. So many times the adoption of this new technology is not as rapid as we want it to be because farmers concentrate mostly on yield. We have to design our message in such a way that farmers also look into the cost aspect of their cultivation.

For this, there is a dual system theory which says that people make decisions according to system 1 and system 2. The quick decisions that we make without much deliberation like farmers

rejecting a technology straight away without much thought will fall under system 1. But system 2 are decisions taken after much thought and deliberation. So we have to bring farmers towards system 2 by making them realize the benefits of this technology.

We have also met farmers who are very inquisitive and ready to adopt new techniques and technology and they want to go to the bottom of things to know what they can do.

Another interesting fact that we discovered during our research was that some farmers initially were not getting very good yield so we asked the farmers the reason for not rejecting this technique when it was not giving the desired results. The farmers told us that they were very happy that scientists and experts from abroad would come to their farm. They would tell others about these visits of foreigners to their farm. This is the reason why we wanted to try it for longer and give it a chance. So recognition also helps in diffusion of technology.

The technology is environment friendly as well. There is also an altruistic side of people. Do you think farmers are concerned about the way they are exploiting their soil and farm? Or if they keep using excess water then water resources would deplete. Or providing more chemical fertilizers is polluting our environment. Do you think farmers care about these things? If they don't then this is our responsibility to make them think about these things. We have to design a message in such a way that farmers think about these things and also adopt our technique.

This subject of behavioral economics is still an ongoing research and we are doing more research on this subject. In the coming time, we will share the scientific based results of any such findings with you. This is a very interesting area of research where a lot of faculty members and researchers can do research on this and better understand the adoption process of a technique.

Thank you.

Download

PDF: Social-Behavioural Challenges

4-Access to CASI Machineries

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Transcript

Hello friends. Whenever we talk about the adoption of conservation agriculture then the availability of machinery and tools on time is very important. This is even more important and true for smallholder farmers. To understand it better, we look at it from a value chain point of view. The most important link in the value chain is the farmer. A farmer needs access to machinery at the required time and he should know how much he has to pay for it. He seeks quality work like if the operator of the machine is not trained then there could be calibration problems in the machine due to which the crop might suffer.

Now, if we talk about eastern gangetic plains, then most of the big farmers here are also service providers. For them, the biggest concern is timely payment of the services they provide. They tell us that farmers get us to work on their farm but then they do not pay us on time. Also conservation agriculture is still not practiced in a large area so the volume of business is small. Another problem that is common is that farms in eastern gangetic plains are mostly fragmented so moving machinery and tractors from one plot to another consumes a lot of fuel which makes it less profitable.

Sometimes, if sowing has already been done in farms that are close to the road, then it becomes difficult to do sowing in plots that

are in the inner parts. At times, the service providers also tell us that they require training on how to operate a newly launched machine.

The third stakeholder in the value chain is the government. In Bihar there is a 50% subsidy on machinery that is related to conservation agriculture. But sometimes this process is very complex and people find it difficult to make use of it. The government is trying to make this process easier and now we also have the option of direct benefit transfer. Government is also into capacity development and this is done mainly through research and development organizations. These organizations not just help in capacity development but also develop prototypes and protocols.

Manufacturers also have an important role to play and their main complaint is that the demand for such machines is less. They say this is not a very big business as it is seasonal in nature and many times it becomes difficult to procure good quality parts and materials for these machines.

Now the most important missing component in the entire value chain is the maintenance workshops. There is still a lack of locally available maintenance workshops because the business for such machines is very less as it is seasonal and also these machines maintenance requires trained people who can fix it. The spare parts of these machines are not easily available in Bihar as most of these machines come from Punjab. So they have to order the spare parts from Punjab.

So we have to understand the entire value chain very well and identify and remove all the shortcomings. Only then we can increase the availability of machines and increase the spread of conservation agriculture.

Now we will discuss the solution to these problems. First, if we want to increase the availability of machines then we have to expand the scaling of conservation agriculture. Once the area under conservation agriculture increases then people will start buying machines and its big business will grow.

Secondly, we can open community based custom hiring centers for smallholder farmers who are not able to buy these machines. In

Bengal such initiatives have proved to be very helpful to the farmers. We will discuss a related case study in the last week of this course.

Some startups also provide conservation agriculture related machines through custom hiring or through service providers. In Bihar we have such a startup called DeHaat with which my friend Shashank is also involved. So startups can also enter and do business in this area.

To strengthen this entire process, we have to do capacity development at every level and we need trained and skilled human resource for it.

By doing all this, we can improve the access of small and marginal farmers to such machines and expand the adoption of conservation agriculture.

Thank you.

Download

PDF: Access to CASI Machineries

PART V
WEEK 5

1-Advantages of CASI-Productivity Benefits of CASI

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://opentextbooks.colvee.org/casi/?p=137#oembed-1

Transcript

Hello friends. We are now into the fifth week of our course in CASI. This is the first lesson of this week and we would learn about the system benefits of CASI.

We know that CASI increases the benefits of our system in four different ways. These are benefits in system productivity, increase in water productivity, increase in energy productivity and input use efficiency. Also, conservation agriculture is based on three main principles i.e. minimum tillage, crop cover and diversified farming system.

We will first discuss the enhancement of system productivity. There is an increase in system productivity if there is an increase in crop yield of kharif, rabi and zaid season crop compared to the conventional system of growing these crops. So to increase system productivity, we have to increase the productivity of various factors that are important to crop productivity.

Now, soil cover, mulching, crop residue retention and minimum tillage are important requirements in conservation agriculture. These things improve the physical character of the soil and help

improve the water holding capacity of the soil which makes sufficient moisture available to crops.

If we talk about the rice-wheat farming system, then if we do DSR under CASI, then we save around 10 to 15 days between the seed to seed period in our rice crop. These 10 to 15-day period is very important for the next wheat crop and as the wheat crop gets more time and our yield also increases.

Now, when we talk about conservation agriculture as system based, we know that we increase our yield by 5 to 10 % when compared to the traditional farming system.

Also, if we improve the water use efficiency of our farming then our system productivity will also improve. In order to increase the use efficiency of water, we have to see that the consumptive use of water is more. To do this, we have to ensure that there is sufficient moisture in the soil.

Also, if we do residue retention in our farm, which is an important part of conservation agriculture then our water holding capacity of soil increases. This improves the water infiltration rate of the soil and reduces the runoff of rainwater and subsequently reduces soil erosion. This means that the top layer of the soil which is the most fertile remains in the farm and this increases our productivity. Usually under CASI, we see the benefits of any activity in the long run.

Now, we will discuss ways to increase nutrients in our farm. Nutrients are more effective in soil where there is sufficient and balanced water or moisture. If there is a lot of water, then the nutrients are washed away with water and this can reduce our fertilizer use efficiency. This is commonly found in traditional methods of farming. Under CASI, we can use different instruments through which we can manage nutrients and increase the efficiency of nutrients.

Now, we discuss water productivity. As we know by increasing water productivity, we mean less loss of water. We have seen that compared to conventional agriculture, there is about 10 to 15% less loss of water in conservation agriculture and this improves our

water productivity by 10 to 15%. Water productivity depends on the residue retention in our farm. With residue retention, we have seen that the water infiltration rate increases and there is a decrease in loss of water through runoff. Also, in conservation agriculture, we use mulch on our farm so there is less evaporation compared to the traditional system of farming. So water productivity is more in conservation agriculture.

Now, we discuss energy productivity. In today's time, we are more and more exploiting our agriculture resources and products though our population is ever increasing and we have limited quantity of land available for farming. But under CASI, our management practice is such that compared to traditional ways of farming, we minimize the use of agriculture products like herbicide, pesticides, fertilizer or use them in optimal quantities. So our energy requirements are more in the traditional way of farming than under CASI.

When we calculate our energy input, we take into consideration that under traditional farming, we till our farm 5 to 10 times whereas in zero tillage we only till it once. Labour requirement is also more in conventional farming and we depend more on machines in conservation agriculture. In conservation agriculture, we save labour during sowing, harvesting and even during postharvest. As we are saving labour, we require less energy input. But, in traditional agriculture, we see that farmers do a lot of tilling and in the process consume more fuel whereas there is less requirement of fuel in conservation agriculture. In the same way fertilizer is extensively used in traditional farming. For the process of weeding, a lot of labour is used in traditional farming but
under CASI, we prefer the use of herbicide. So overall, we use more quantity of products in traditional farming when compared to conservation agriculture and as a result we spend more energy in traditional farming. On the other hand, in conservation agriculture, we optimally use these products and because of which our input energy is less.

In conservation agriculture, we say that there is 5 to 10% increase

in system productivity. So if output energy of both traditional farming system and conservation agriculture is same, then as input energy is required less in conservation agriculture, we can safely say that we produce more energy by investing less energy in conservation agriculture.

Now in terms of input efficiency as we are using many different products in traditional farming, the effectiveness and utilization of these products cannot happen fully. But in conservation agriculture, say if we are using nutrients then there are many techniques and instruments to assist us like leaf color chart or green seeker. If we use all these things, then we prevent ourselves from using more nitrogen. So our input use efficiency and its productivity increases as we are using less amount of nitrogen and our productivity remains the same.

Now, why do we get these productivity benefits? If we talk about the entire CASI system, we notice that there is a 5 to 10 % increase in our yield. There is also 10 to 15% increase in water productivity, 20 to 40% increase in farm income. The main reason for increase in income and profit is that we are saving around 4000 to 5000 rupees per hectare from not tilling. In a year, we save around 40 to 45 labor man days per hectare. So from all the savings what eventually happens is that we save our cost of cultivation and even if the return is same when compared to the traditional way of farming, we are able to profit more. In other words, our benefit cost ratio increases.

So from CASI, we are able to profit more in every parameter be it productivity or water productivity or energy saving or energy productivity or input efficiency.

Download

PDF: Productivity Benefits

2-Economic Advantages of CASI

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Transcript

Hello friends. This has been fully proven that conservation agriculture is a very beneficial technique of farming. But the most important thing for farmers is the economic advantage of a farming technique. Today we will discuss this aspect and look into the various cost savings that come with the adoption of conservation agriculture when compared to traditional way of farming.

Various research studies have been conducted in different locations on conservation agriculture. There will be minor variations in the findings of these studies but all of them show that conservation agriculture is beneficial. We conducted research in the Eastern gangetic plains of India, Nepal and Bangladesh for all types of cropping systems like rice-wheat system, rice-maize system, rice-lentil system or rice-jute system. We found various advantages of conservation agriculture. The overall result of our findings was that CASI is more beneficial than conventional tilling.

To understand it better we look at this graph. There are four treatments. T1 represents conventional tillage meaning puddled transplanted rice after which rabi crops like wheat, maize or red lentil are sown on tilled plot. T2 represents puddled transplanted rice but the rabi crop is done through zero tillage. T3 represents DSR and then zero tillage for rabi crop. So this is a full CASI

technique adapter. T4 represents UPTR meaning unpuddled transplanted rice and then rabi crop is grown with zero tillage.

These four categories were analyzed in nine different dimensions and it was found that CASI which is represented by T3 is the most beneficial in all dimensions. This was true for all the 9 dimensions of comparison like the system rice equivalent yield, cost of production savings,laboursavings, energy saving, irrigation water saving, gross margin, input water productivity, energy productivity and CO2 emission benefits. In all of these categories, you can see that T3 is the most beneficial. We have kept them in an index of values from 0 to 1. We can see that the most valuable is represented by the value 1 and least valuable are going towards the value 0.

The second best system after T3 is T4 i.e. unpuddled transplanted rice and zero tillage for rabi crop. It has the same benefits when it comes to water saving with other systems but in all the other parameters this system is more beneficial.

Then comes the T2 system where we did puddled transplanted rice followed by zero tillage for rabi crop.

In the end is conventional tillage system i.e. T1 and it is shown that the other three systems are more beneficial than the conventional T1 system.

Another study done by FAO has shown that we can from the time of land preparation to the time of crop establishment, save around 80% consumption of fuel if we are doing conservation agriculture. We save around 60% labour compared to conventional tillage in conservation agriculture. In our study of the 3 countries of Nepal, India and Bangladesh, we found that 40% cost can be reduced and 25% gross margin gain in conservation agriculture compared to conventional tillage.

Overall, farmers can save approximately a minimum of 2500 to 3000 rupees in conservation agriculture when compared to conventional tillage.

So friends, conservation agriculture is very beneficial for farmers. In times of climate change, conservation agriculture comes forward as a very good solution and it is also very beneficial for the farmer.

Download

PDF: Economic Advantages of CASI

3-Soil Health

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://opentextbooks.colvee.org/casi/?p=141#oembed-1

Transcript

Hello friends. Today, we will talk about soil health. We will discuss what is soil health and what is its relationship with soil quality. We will also look at the main components of soil health.

Soil health is something basic that we can feel and understand but it is difficult to measure. Soil health is just like human health but doing an assessment of soil health is very difficult. Soil health depends on soil quality. We cannot directly measure soil quality so we do an indirect assessment of it through soil properties. We do have vast knowledge about soil health but we cannot just summarize it into a simple formulae or indicators like we do for human health.

The best indicator of our soil health and soil quality is our crop yield. As we cannot directly measure the soil quality indicators, we measure the soil properties to get an idea about the soil health. So a straight forward measurement of soil health is not possible that could give us a clear result if the soil is healthy or not.

Soil health works on two important properties: inherent soil properties and dynamic soil properties.

Inherent soil properties include things like with which rock the soil is made of, the time of soil formation and its parent material. It also includes things like the topography of soil, what was the vegetation and how long did it take to be formed.

Now, major soil classifications are described and divided under inherent soil properties. We can check the different types of soil like its parent material and if the soil is acidic or alkaline, productive or unproductive.

Soil health also depends on soil dynamics which includes things like the land use, what was the cropping system, how was cultivation and management done and the decisions. Soil quality depends on the above and they are influenced by soil health, management, cropping system, farming system, temperature, seasonal crops. So their overall management governs to soil health

So the dynamic and inherent properties are the factors that govern soil health. Soil health depends on three properties: physical properties, chemical properties and biological properties.

All these three properties indicate soil quality. Soil's physical properties function is to support the plant so that it can stand upright and grow. It also controls soil erosion. If the physical condition of soil is good, then soil erosion will be less and if it is bad then the soil will erode with water. The hardness of soil also depends on soil physical properties like if the soil is hard or soft. Soil physical properties also help with water retention and the movement of water within soil profile.

Soil chemical properties function is to retain the nutrients and also how to release them. It also controls soil reactions like EC and pH. Carbon energy storage also depends on soil chemical properties.

Soil biological properties affect weed, pests and diseases and their suppression. The growth of microbial population in the soil like micro-roots and micro root zone depends on biological properties. Organic matter decomposition rate and the N mineralization of soil i.e. nitrification and denitrification is also governed by biological properties.

Now we look at soil physical properties. It includes soil temperature called also soil thermodynamics, soil moisture, **bulk density**, hardness of soil, soil permeability and soil composition and aggregation.

The soil chemical properties include EC and pH, available nutrients, total nutrients, total organic carbon and available carbon etc.

The biological properties include the growth and population reactions of bacteria, fungi and actinomycetes. It also includes insects and pest related disease and their growth and seeds.

The organic matter decomposition depends on microbial population and bacteria. It will also be according to soil biological properties. It includes the rate of organic matter decomposition if there are more bacteria or actinomycetes or fungi in the soil.

So these were the three soil properties and now we will discuss them further in detail and how management affects them.

We had discussed earlier the relation between residue retention and soil physical properties. We will also talk about soil health under CASI and how soil physical properties are governed.

We will first talk about soil permeability or infiltration. If we practice residue retention and conservation agriculture for a long time, then the soil permeability or infiltration or water soaking capacity increases. This recharges the aquifer and also prevents water logging and crop burn out.

If we do zero tillage and conservation agriculture continuously then the soil aggregation i.e. there is improvement in small lumps of soil. This helps wit overall soil composition and structure.

If we retain residue, then our moisture is conserved and that regulates our temperature. This can moderate temperature by 5 to 6 degrees which is very beneficial during extreme high and low temperatures.

If we practice CASI and retain residue and do zero tillage and crop diversification, then it conserves water as the capacity to retain moisture increases. This is possible because the soil physical properties like soil structure temperature and **bulk density** improves and as a result the water retention capacity increases. Also the mulch helps prevent water evaporation.

Now we look into soil biological properties and the enzymes like bacteria, fungi and actinomycetes. If you look at the graph, the

population of dehydrogenize activities and enzymes increase. The total microbial carbon and actinomycetes increases. So we can see in the graph that all the three enzymes population increases where residue retention is practiced. But their population falls where there was no residue retention and tilling was practiced. We have 28% growth of bacteria, 68% growth of fungi and 98% growth of actinomycetes where we do zero tillage and residue retention and mulch.

This was all for micro fauna. But the macro fauna population also increases like soil and seed predators and many other beneficial insects. The population of earthworms also increases. So the overall biological properties of soil increases and there is self-tillage in the soil like if the population of earthworm increases then they till the soil on their own and release nutrients.

Now, we discuss soil chemical properties, especially soil organic carbon. This is directly associated with how much organic matter we are providing to the soil like farmyard manure, crop residue or any other plant biomass. So in the graph, we can see that after 5 years of CASI, if we are continuously providing residue of all the three crops then the value increases from 0.45 to 0.9. So the soil surface values doubles.

The benefits of it in soil profile will be less and will only be found in the long run. So this is over all an improvement in soil carbon.

Another thing we notice in the graph is that the amount of available macro nutrients like nitrogen, phosphorus, potassium and Sulphur increases and they are easily available to the plants. Now the availability of micro nutrients like iron, zinc, manganese, boron and other non-essential but important nutrients like silicon also increases and so there is good plant growth.

So if there is overall improvement in physical, biological and chemical properties then we can see in the graph the photosynthesis rate of plants increases. The canopy temperature which is very important in the later stage of plant, if at that time our temperature is maintained then there is good grain filling and grain weight as a result of which we get good production.

Overall if our soil health is good, our soil quality indicators like physical, biological and chemical properties are good then our overall soil and plant and water relation improves and as a result we get good crop and yield.

Now, we will look at the advantages. The soil's physical, chemical and biological properties are very important for soil health. If we have a problem in one of the properties, then we won't have good soil.

The soil health improves under CASI as compared to traditional farming as the three chemical, biological and physical properties of soil improves.

If our soil is healthier then we will get good quality yield and we become healthier by eating good quality food.

The soil health and soil quality takes years to improve but if we want to destroy it then we can do that in just one year by adopting wrong practices. It is just like human health where it takes years to keep good health but in just one month we can get any diseases or anything by eating unhealthy things.

If our soil is healthy then our plant will be healthy and it would have better resilience against climatic shocks. This can improve our income and the quality of food we eat and the quality of soil for our future generation will be better.

It is very important to maintain the soil health.

Thank you and hope you enjoyed this chapter.

Download

PDF: Soil Health

4-Climate Resilient and Environmental Benefits

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Transcript

Hello friends. We know that agriculture provides us with our basic needs like food, fuel and fodder but it also contributes to the emission of greenhouse gases. These gases are released through soil organic matter decomposition or the use of fossil fuel or through residue burning.

In the last 30 – 40 years, we extensively practiced tilling soil and this released 30 to 50 % carbon from our soil into the environment resulting in the deterioration of our air quality.

Now, conservation agriculture is being looked at as a potential solution. We had looked at the three main principles of conservation agriculture: minimum tillage, soil cover and crop rotation. If we do minimum tillage and permanently or semi cover the soil, then there will be reduced emission of carbon in the environment and our soil will be healthy. We can understand it better by looking at the Reicosky, 2003 'C wheel'.

We can understand carbon in two parts. First, if our soil is fertile then there would be more organic matter in the soil and we would get good production and this will improve our economic condition. Second, if we stop carbon emissions then CO2 sequestration will

stop and our air quality will improve. If we have more organic matter in the soil, then the water holding capacity and the use efficiency will increase. According to a study by Hudson, if we increase the organic matter by 1% then the water holding capacity of soil increases by 3.7 %. Also more organic matter in the soil means that water will seep into the soil slowly and reach the plant. The rain water will also infiltrate and go down.

The Cation exchange capacity(CEC) will increase and this will increase the availability of nutrients. One study has shown that if we increase the organic matter in the soil then it increases the CEC by 20% to 70% provided they are clay minerals or metal oxides.

Conservation agriculture also stops soil erosion by almost hundred percent as the crop residue decays slowly and a layer of organic matter develops. In fact, conservation agriculture had started as a response to the problem of soil erosion.

This also improves the water quality. When there is an increase in organic matter then there is also increase in biological, physical and chemical activities and this decreases soil compactness. This leads to an improvement of soil structure and tilth and there is aeration for the plant. All this slowly reduces the release of CO2 in the environment as the carbon is being trapped in the soil and less of it is released.

One benefit of this is that as there is more organic matter in the soil so we require less fertilizers. Also due to tilling, the availability of nitrogen increases in the short term due to mineralization but in the long run the availability of nitrogen decreases.

There is an increase in soil buffer capacity and in biological activities. As we are not disturbing the soil structure, there is an increase in the different types of biota in the soil. They get an ideal environment and their numbers and variation increases. Also there is no run off when we use pesticide or herbicide in our farm as there is a layer of organic matter that absorbs and increases the efficiency of pesticides.

So we can say that carbon is at the center and plays an important role. Conservation agriculture increases the availability of organic

matter. In a research conducted for Eastern gangetic plains, it was found that if we do conservation agriculture then almost 10% CO2 equivalent emission decreases and this figure was between 10 to 20% in other studies.

Besides this, conservation agriculture mainly zero tillage and DSR, there is increased resilience against climatic shocks like floods and drought. I would like to share an example with you. We had organized a DSR demonstration in Kathaili village. Now there was an unexpected flood during the month of September in that village and we found that farmers who had done DSR in lowland, their crop was saved while the transplanted paddy crop of farmers next to the DSR plots did not survive the flooding.

Like I said earlier, with conservation agriculture, the water holding capacity increases as there is an increase in organic matter and water slowly is released for plants. So even in drought like situations, the plant gets water.

We had also looked earlier at how crop residue retention maintains the balance of temperature between 5 to 6 degree Celsius. So due to climate change, if there are any variations in temperature then our yield does not get affected by such things. Therefore, we can say that conservation agriculture is climate resilient and it has many benefits.

So friends today we looked at the various environment related benefits of conservation agriculture. Conservation agriculture increases our production and improves our economic condition.

Thank you.

Download

PDF: Climate Resilient and Environmental Benefits

5-Social Benefits

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Transcript

Hello friends. This week we learnt about the various advantages of conservation agriculture like how we can increase system productivity and the economic advantages it has. We also looked at the environmental benefits of conservation agriculture. There is one more important aspect that we have to look at. Agriculture is a system with a family approach. This is even more true for developing countries like most of south Asian countries. As agriculture is family based both male and female members of the family work in the farm. These days'feminization of agriculture is a very talked about subject. Also, when we talk about Eastern Gangetic Plains then the migration rate is also very high. So, keeping these things in mind, today we will discuss the social benefits of adopting conservation agriculture.

First, if we adopt conservation agriculture then we can also do some alternate income generating activities. For example, we were in Katheli village and a women farmer by the name of Rekha had done CASI farming in half acre. Keeping in line with our goal of intensification, she also grew some vegetables in her Maize farm. She was able to earn 5000 to 6000 by selling these vegetables. After this, she also got maize crop from her farm. So in this way, if we adopt the principles and technologies of CASI, then we can also

engage in alternate activities. This is especially true for women as most farmers are small cultivators and there is a lot of migration because of which women have to take care of the farm.

The second benefit conservation agriculture has is that it is a labour saving way of doing farming. If we do DSR, then we don't have to do puddling and transplanting. Now mostly, I would say around 90% of the transplanting work is done by women. So it requires a lot of drudgery and we can avoid all this by adopting conservation agriculture. Women then can spend their time in other income generating activities. In Bihar, there are many self-help groups for women and these groups also work on women entrepreneurship. So if women are able to spare time from agriculture then they can spend that time on their family or on any other entrepreneurial activities.

This also works as an empowerment. When we started our work through a self-help group, then some women came forward and told us that they will adopt conservation agriculture. These ladies worked as our ambassador and told other women about it. So in this way, these ladies got recognition and also a source of some additional income. Such social benefits come out of conservation agriculture. Basically, male and female farmers who are able to save time from this can use that time in other activities.

The benefit that farmers derive from conservation agriculture, they can spend that in education and food. So their nutritional security also improves.

One of the principles of CASI is intensification and it brings diversification to our farm and this leads to more income generating activities.

One of the social benefits of conservation agriculture is that women do extremely laborious work like transplanting or weeding. They can save time from these and instead spend that time on other activities. Overall, there will be an improvement in the household activities.

We would also have to design machines that come under CASI to be gender specific. Like the machines are very heavy and it is very

difficult to transport them from one place to another. So we have to work on how to make these machines accessible to women and how to make small machines so that women are able to operate it.

So friends besides other advantages of CASI, one benefit that we see coming out is the social benefit. If everyone works together then there will be scaling out of conservation agriculture and the business will increase and other people in the society will get employment. Service providers can buy more machines and expand their employment. So, conservation agriculture has a lot of advantages.

Download

PDF: Social Benefits

PART VI

WEEK 6

1-Business Model-Startups in CASI

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Transcript

Hello friends. In the last 5 weeks, we learnt about CASI, the machines it requires, its advantages and residue management. We also looked at the challenges we face if we are doing conservation agriculture. Now we will look at if there are any business opportunities in CASI in addition to doing just farming. We will see that there are such opportunities available and in today's lesson we will look at the topic of startups in CASI. We will talk about how to set-up a startup under CASI and how to work with a business model under CASI.

Now what is a startup? Of late there is a growing trend of startup businesses in India. The Government of India has set up three criteria to define a startup. The first is that the business or venture should not be older than 10 years and it should be registered as a private limited company or partnership or via an LLP model. The second criterion is that the business turnover should not exceed 100 crores. And the final criterion is that the business should involve innovation and product or service improvement and should have scaling and employment generation potential. The above criteria's need to be fulfilled in order to be registered as a startup.

Now we will try to understand the business ideas and areas where we can establish ourselves as a startup. The first thing that we had

learnt was the availability of machines for CASI to be successful in India or EGP. So a startup can enter into the area of machine manufacturing and service provision. A lot of times it is the big farmers that have powerful tractors who work as service providers. Many times they complain of not having enough business for their services. So we will look into how we can overcome this and grow as a sustainable business model.

Some farmers not just became service providers but they also underwent training and started training other farmers. So with the success of CASI, its adoption area will increase and as a result the business of service providers would also increase.

One can also work as a retailer. There is also potential of a business venture into solving maintenance issues and providing on site home maintenance services as sometimes it gets difficult to find spare parts or resolve maintenance issues.

Second, from the perspective of farmers is the availability of quality inputs. When we do DSR, then the use of herbicide is very important. Seeds are required in both conventional agriculture and CASI. Once we have a relationship and network established with farmers then we can also provide quality seeds, fertilizers and pesticides to farmers.

Some have started providing 360 degree solutions to farmers where they offer certain packages to farmers and take responsibility for their crop from sowing till harvest and they also guarantee that there will be no decrease in their crop yield. We will look at such a case study in the coming lecture.

In West Bengal there was a case where some women and a local farmers group got into the production of mat nursery and started selling it to other farmers. They developed a business model around this activity.

There is also the scope of consultancy as this is a new technology and one can provide consultations and machinery to farmers.

Once we have established a network, then we can also get into output marketing. We will discuss the DeHaat model and how they buy maize from farmers and sell them to international and national

markets. This proves beneficial to farmers and also profitable to DeHaat.

I will now provide some advice on how we can scale out a sustainable business model as one might feel that very few farmers are doing it and not much area is under its practice.

Our suggestion would be to always do it in a group as opposed to doing it individually. With a group approach as scaling takes place, our business would also increase at the same time. In West Bengal, conservation agriculture was started through multiple farmers' clubs and hundreds of farmer clubs joined hands to expand conservation agriculture. So the bigger our network is, the bigger will our business grow. In Purnea, we worked through Aranyak company that was backed by JEEViKA in the promotion of conservation agriculture. So conservation agriculture can be promoted through a producer company.

When we introduce a new technology then a lot of new stakeholders also come in the picture. Like in the case of zero tillage machines, there are sellers who have never sold this machine or will be selling this machine. There will be people who will provide technical knowledge of this machine. So new stakeholders get involved with the technology and with old stakeholders who are already in the market and social system, a new type of structure and system is formed whom we call an innovation platform. We prepared an innovation platform under the SRFSI project and through this network we can promote conservation agriculture.

So this is how we prepare a new network which is efficient. It should put too much burden on farmers and should be profitable for the farmers and all the stakeholders. People will get involved in this new technology only when it is more profitable than the existing conventional system. So we have to make sure that all the parties involved in this technology like farmers, manufacturers, marketing, input retailers of seed and fertilizers, and everyone else involved find its adoption profitable.

We will soon look at the concept of micro entrepreneurs brought by DeHaat. They developed micro entrepreneurs at village level and

connected farmers with them. They started providing end to end services to them. We would discuss this in detail as part of a case study.

So friends, conservation agriculture is in a way new for eastern gangetic plains and its area is growing very fast. There are a lot of opportunities available for new startups in this field.

Thank you.

Download

PDF: Start-ups in CASI

2-CASI Value Chain-One Stop Solutions

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Transcript

Hello friends. Today, we are in Satmile Satish Club in Cooch Behar. You must have come across words like startups or entrepreneurs. Today, we are with such a startup that started out with conservation agriculture and now has successfully expanded to its allied sectors like fisheries, poultry, selling input to farmers and providing machines to them. This enterprise also works in the area of capacity development of farmers and also provides them with important information.

We have Amal ji with us and from him we shall know how he started out on this journey.

Hello. My name is Amal Roy and I am the secretary of Satmile Satish Club. Our enterprise works as a custom hiring Centre. We started working on conservation agriculture from the year 2009. Now, we have started to work on SRFSI project based on conservation agriculture. Our focus is on rental model. We provide every type of conservation agriculture based machines on rent to farmers. Farmers are able to do farming on a larger area in less time with these machines. This is beneficial to farmers as it is cost effective. In addition to providing machines on rent, we also have an input shop where we sell inputs to farmers. Our shop has all kinds of

pesticides, insecticides and fertilizers. We also provide agriculture advice to farmers.

Our Satmile Satish Club is connected directly to around 30,000 farmers and indirectly to around 1 lakh farmers through FPC (Farmer producer organization). For this, CIMMYT and Godrej agrovet is providing us with the required funding for 3 years for the capacity development of farmers. Through this initiative, we have done a lot of capacity development work for farmers. As a result, technology is getting popular among farmers. Also as there is a lot of labor problem, so farm mechanization is very important and is being introduced through a rental model. This work is being done throughout West Bengal.

In 2009, we started our work through zero tillage with KVK. Now from 2014-2015, we got associated with SRFSI project with KVK.

In the beginning, when we started to work on conservation agriculture based zero tillage, it was very difficult to convince people to practice zero tillage wheat and maize. So we would organize a lot of training programs and capacity building in association with the agriculture department. We would also organize a lot of demonstrations.

By doing all this, we explained to farmers that we can do conservation agriculture based zero tillage under SRFSI project. During that time, there were problems in rice transplanter technology. Farmers were unable to understand how to grow seedlings so we worked on their capacity building of raising seeds through farmer's club.

The rice transplanter machine does uniform sowing of rice. Its main advantage is that it costs just around 1500 rupees per acre to the farmer with a rice planter as opposed to 3600 to 3700 rupees during transplanting with labor. Farmers are able to save time as they are able to transplant a one-acre field in 2.5 hours. So farmers are happily accepting this technology in renters' model as they are able to save cost and time.

Parutosh Da has completed a diploma in fertilizer from Cooch

Behar KVK. He provides farmers with the correct advice and guides them in the right direction.

This is the training centre of our Satmile Satish club. We provide training to farmers over here. Farmers from other blocks and even other countries come here for training. This is our conference room. We also have a residential facility and a place to stay upstairs.

When we talk about business then it should cater to the problems of someone. We saw how Amal ji first understood the needs and problems of farmers. He has every type of machinery that one needs be it small or big.

We know agriculture is a system. Many times we just provide information or just capacity development to farmers. But over here, he has developed this enterprise as a one stop solution where we can find machines, technology, capacity development, quality inputs and free information. So he has developed a 360-degree business model. So far he has only touched a few dimensions of the value chain. Agriculture is a very big sector and conservation agriculture has immense scope.

So any new upcoming startups can learn from this case study and begin their own startup and also work together with Amal ji.

Thanks

3-Mat Nursery: A Profitable Venture

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Transcript

We have developed a seedling factory on renters' model through which farmers get seedling and rice transplanter services. Farmers are able to save time, money and their yield also increases.

You can see over here a seedling factory is at work. Just like this, around 35 farmers' groups or clubs are growing seedlings in our district. It is our business model and we sell seedlings to the farmers. The farmers are also able to save time.

Over here is a 4 feet wide seed bed. We prepare the bed with soil and organic matter. We mix 20% organic fertilizer with soil and then screen and separate the dust and transfer this soil to the seed bed where we do seeding.

After preparing the soil, we place a plastic on the seed bed. These are mat seedlings and it requires plastic.

You can see our workers are at work. This soil has 20% organic stuff and the rest 80% is soil. We mix them and prepare a seed bed with them. The seeds are used to grow seedlings. Once the seedlings are ready, we cut it in 1×2 feet layers and transport them in a tray to farmers.

You can see the seed bed is ready after which we provide water and do the seed sowing.

You can see the seed sowing is taking place. This is the seeder

machine and it does sowing in a uniform manner on the mat seedling bed for the rice transplanter machine.

After seed sowing, we spray fresh water to increase the moisture. We also cover the mixture of organic fertilizer and soil. Once the entire process is complete, we give it plastic and keep it like that for 17 to 18 days. We remove the plastic after 3 to 4 days when we have to take out the seeds. We do this because of the cold. After 13 to 14 days we open it up.

You can see that the seedling is ready after 13 to 14 days. We will cut it and transport it in trays to the farm.

You can see we are putting the seedlings that germinated on plastic on the trays.

We require 60 trays for an acre of land. It cost 2400 rupees per acre to the farmer for seedlings. If the farmer does traditional transplanting then, only for seedlings, it would cost him around 4500 rupees per acre. So the farmer is able to save time and money with this technique.

Once we bring the rice seedlings that we developed in our seedling factory, we provide service to the farmers in their farm. We set the seedlings in the transplanter machine for transplanting.

4-DeHaat-One Stop Solutions

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://opentextbooks.colvee.org/casi/?p=153#oembed-1

Transcript

Hello friends. Today, we want to share a case study with you that provides 360 degrees one stop solutions to farmers. They provide every kind of input and information to the farmers from seeds to anything in the market. This is a Bihar based startup called DeHaat and it was started by a group of 5 people. They provide all kinds of services to farmers. As part of the SRSFI project, we requested them in 2015 to start working on conservation agriculture in Purnea district. We will look at how they started and developed a sustainable model and established a business on conservation agriculture.

First, they have a mobile app through which we can order any inputs and get them delivered to our home. We can also sell our output through it. But there are difficulties as many farmers are difficult to connect as they are not very ICT literate. To overcome this problem, DeHaat made micro entrepreneurs or DeHaat coordinators at village level and they started working as nodal officers with whom the contract farmers would work. So if any farmer needs any input then they will contact the micro entrepreneurs and get the needed things.

Now like I said earlier, a problem in conservation agriculture we face is that of machines. So DeHaat bought a lot of machines like

laser land leveler, zero tillage machine or small harvesting machines or rain guns. They bought these machines and organized demonstrations among farmers and started to work as service providers.

Many times as part of our project, we would need machines like we did land levelling of many farmers as part of the project. So we provided the contract of doing such things to DeHaat and this helped them grow their business. They did very well in marketing maize crop and they established a network with farmers. In addition, they also started providing information through sms or call centre. These days they also provide credit to farmers. They started providing information and services about how much fertilizer and what quality is required for soil testing and about insecticide and pesticides.

BAU also started providing technical backstopping about conservation agriculture to them and other people from the project also started working with them. They were able to set up a sustainable private business institution in Purnea. Today, farmers are able to get services in a timely manner and DeHaat is able to profit from such activities as they now have a network setup.

There are three main things behind the success of DeHaat and how the business model turned out to be a successful sustainable model. First, it works on an end to end one stop approach. If anyone wants to buy inputs, then they can do that through DeHaat or if anybody wants to sell their output then they can also do that through DeHaat. Earlier, vendors were into malpractice like cheating while weighing output so they used electronic weighing machines or cheating farmers in the name of moisture. Also, many times farmers would give their output to vendors and then they had to wait for their money for like 3 to 6 months. In worst case scenarios, the vendors would run away. So farmers would incur a big loss because of these things. But DeHaat, provided an assured medium to sell output and would promise payments within a week. So in this way, DeHaat did very well in output marketing.

The second success point after the end to end approach is the

flow of information. We are wrong to think that a technology will scale out just by providing machines, seeds or quality inputs. We have to also provide the protocol or information related to the technology to the farmers. So DeHaat collaborated with BAU to work on this information flow.

The third success point is relationship building. They formed a relationship and network with the farmers and made them a contract farmer and micro entrepreneurs. So these three points of end to end approach, flow of information and relationship building helped DeHaat become a successful business model.

So friends, there is a lot of work that young entrepreneurs can do in this value chain. Farmers can also benefit from this and at the same time also set up a successful business model.

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5-Learning Experiences vis-a-vis CASI

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Transcript

Friends, today as part of this MOOC course, I would like to share my experience with you all. I remember in 1998, the National Agricultural Technology Project was being run by ICAR and a project was formulated in resource conservation technology. The objective of the project was resource conservation in technology for accelerated growth in agriculture. Nine centers were included in this project including Punjab and Haryana. One of the center's was the western Uttar Pradesh centre of project directorate for cropping systems research where I was working at that time. Not many scientists were keen on taking up this project and also the director of the centre was not very fond of me so he handed over this project to me.

I read the details of this project and attended the preliminary meeting of this project. I had studied in BSc. Ag about zero tillage technology but I was not much aware about its application. So when we used to go to farmers then they would come to us in large groups of 50 to 60 people. They would laugh among themselves when we would talk about zero tillage technology and that we wanted to sow wheat without tilling. It would appear that they had never heard anything like this before. Also in western Uttar Pradesh it has been a tradition that as a farmer gets up in the morning, they go to their

tractor and till their farm. In such an environment, we practically had to request them to come forward and adopt zero tillage and also guarantee compensation for any losses incurred in the process.

Still only few farmers came forward reluctantly and some of them would plough their fields when we were not present and would lie about doing zero tillage. But they had indeed reduced the amount of times they till their farm. Earlier they would till their farms 7 to 8 times but now they do it only 1 or 2 times. In the first one or two years, farmers watched the results of demonstrations that were organized on zero tillage and luckily during this time, there was good rain. Along with rain there were also winds which lodged down wheat that were planted on tilled soil while the zero tillage wheat stood strong. Farmers also noticed that this technology has less growth of weed.

The first year, we were not able to convince farmers about zero tillage but from the second year, they themselves would come to us and say that I have done zero tillage farming in my field and also that it requires only two hours to irrigate farm as compared to the traditional way where it would take nearly 3 hours to irrigate the entire farm. So all these things slowly started getting popular among farmers and by the second and third year, we had to face less problems.

When work on Zero tillage technology started, it was not meant only for western Uttar Pradesh, Punjab and Haryana. It was also understood that zero tillage would have a significant contribution in Bihar as it could reduce the time between rice harvest and wheat sowing. It could bring forward wheat sowing by 10 to 15 days depending on the situation of moisture in the soil. In Bihar there was acceptance of zero tillage technology when it was first introduced as they could do early sowing of wheat.

In Bihar, we know that wheat always dries rather than maturing and this is the reason why wheat production is lower in Bihar when compared to other states. Zero tillage was introduced in Bihar with the objective of sowing wheat crops early. So the motive of farmers in Uttar Pradesh, Punjab and Haryana was different from the

farmers in Bihar as over there farmers were looking at minimum tiling cost and irrigation and less weed growth with almost similar yield. So farmers understood that they could reduce their cost of cultivation by 3000 to 4000 rupees per hectare with slight or similar production levels resulting in higher profits. In Bihar, farmers understood that they could sow wheat at the appropriate time and thus avoid terminal heat.

The second phase of National Agricultural Technology Project (NATP) was sanctioned by the world bank after the then director general of ICAR made a statement about the project in a meeting with the world bank team. He said that with zero tillage technology, we were able to provide benefits to farmers equivalent to the total outlay of NATP. This was a very convincing point and the second phase of the project was sanctioned without any further discussions.

I have been working in Bihar on zero tillage and have noticed that though zero tillage has been accepted in Bihar by farmers but its farming has not expanded in a similar proportion. We tried to look for answers and found that the biggest problem that we are facing is the availability of machines. In Bihar, around 90% farmers are small and marginal farmers who do not have the capacity to buy a zero tillage machine and use it in their own farm. It is not profitable for them to use the machine just on their own farm as the machine requires an investment of about 50,000.

In its early phase, a group tried to stop the expansion of zero tillage as a lot of tractor owners' main source of income was the tilling of fields and they would practice tilling 5 to 6 times in a field. So this group started a negative campaign against zero tillage in the early phases. But farmers are very smart and intelligent and they can do all the calculations and realize that this zero tillage is very beneficial and has a lot of scope in the future.

There was also the problem of repairing this machine if it stopped working. We did not have the expertise to repair these machines. The agriculture university had the knowledge to repair the machines but it was not possible to go everywhere and provide

repairs. So we started a training program under skill development where we train the local youth on how to overcome the common problems that one has to face while using these machines. We have also requested manufacturers to keep stock of certain machine parts that are more prone to break down. So to an extent we have been able to find solutions to these problems.

The motto of "Jal, Jeevan aur Haryali" provided by our chief minister is getting popular among our farmers. We all agree that if there is water, then there will be life and greenery. We know that zero tillage technology requires less amount of water. The government has also appreciated the benefits of zero tillage technology and they are now providing subsidies of around 80 to 85% on machines and equipment for farm mechanization. Farmers are able to benefit from these schemes and the government is also trying to make available all machines in each cluster. Some machines are big and they are also made available so that farmers can use it. Our university is working on this initiative and the Bihar government is also supporting us in this endeavor. Compared to when we started working on Zero tillage, the number of problems that are reported to agriculture universities and other such organizations have definitely reduced.