W03L01: Land Preparation

Dr. Sanjay Kumar
Chairman, Dept. of Agronomy, BAC, Sabour

Land Preparation under CASI

- ✓What is land preparation?
- ✓Field condition/soil type
- ✓Pre-requisites of zero tillage
- ✓Benefits of zero tillage

Land Preparation

- Land preparation is important to ensure that the field is ready for planting
- Control weeds
- Recycles plant nutrient
- Provide suitable environment for direct seeding
- Land preparation covers a wide range of practices from zero-tillage or minimum tillage which minimizes soil disturbance through to a totally 'puddled' soil which actually destroys soil structure.

Pre-requisites of zero tillage

- ✓Laser land leveler
- ✓Residue retention
- ✓Use of suitable machinery
- ✓Control of weeds

Benefits of Zero tillage

- Reduction in the crop duration, thereby early cropping for second crop
- Reduction in the cost of inputs for land preparation (60-80%).
- Residual moisture effectively utilized.
- Organic matter added to the soil.
- Environmentally safe
- ZT reduces the compaction of the soil.
- As the soil is intact and no disturbance is done, No Till lands have more useful flora and fauna.

Good Agricultural Practices

- Establish a detailed knowledge of the nature, properties, distribution, and potential uses of soils
- Avoid soil disturbance to the extent possible.
- Avoid soil compaction beyond the elasticity.
- Maintain soil organic matter during rotations.
- Maintain organic cover through crop residues
- Maintain balanced nutrient levels .
- Avoid contamination with agrochemicals
- Maintain record of the annual use of inputs/outputs.

W03L02: Herbicides Application

Dr. Sanjay Kumar
Chairman, Dept. of Agronomy, BAC, Sabour

Herbicides application

- ✓ Why we use herbicides in CASI
- ✓ Types of herbicides
- ✓ Time of application
- ✓ Types of nozzles
- ✓ Calibration of sprayers
- ✓ Safety measures

Why we use herbicides in CASI?

- ✓ Higher weed pressure with minimal tillage increases peak labour demand
- ✓ CA increases labour requirements during the cropping season for weeding when implemented without herbicides.
- ✓ Reduced tillage systems relying purely on manual techniques for weed control are not an attractive option for smallholders.

CA with Herbicides

- ✓ With use of non-selective herbicides, all weeds can be removed in a single operation.
- ✓ If weed control is achieved with herbicides, the labour requirement is reduced.

Herbicides

Herbicides are chemicals that are used to kill undesirable plants, such as weeds. The proper use of herbicides has many benefits in saving money, time and labour. But it also can cause problems such as killing non-target plants, and some herbicides, such as Roundup, could be associated with a high risk of some cancers.

Types of Herbicides

- On the basis of effect
    1. Pre- emergent herbicide
    2. Contact
    3. Systemic
- On the basis of selectivity
    1. Selective herbicides
    2. Non-selective herbicides
- On the basis of state
    1. Granule
    2. Liquid
    3. EC, etc

Types of herbicides

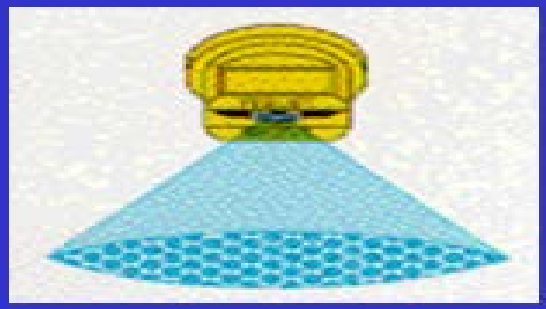
- On the basis of application
    1. Pre-plant application
    2. Pre-emergence application
    3. Post-emergence application
    4. Harvest aid application

Nozzles

Hollow Cone

- not for herbicides
- produce a fine spray that is concentrate on the outside edge of the spray pattern
- suited for insecticides and fungicides

Flat Fan



- tapered pattern
- provides uniform application when overlapped with the same nozzle type
- Best choice for herbicide applications made with multiple nozzle booms

Flood (cut) tip

- Pattern tends to be heavy toward edges
- coarse spray pattern with large droplets
- wide spray swath at low pressure
- Less drift

Pesticide Safety

- Wear boots, long trousers and rubber gloves when spraying
- Keep all pesticides out of eyes and mouth
- Avoid contact with the skin
- Wash with soap and water if contact occurs
- Do not eat, drink or smoke while handling pesticides
- Change and wash clothing after spraying
- Do not reuse empty pesticide containers

W03L03: Weed Management for ZT Crops

Dr. Sanjay Kumar
Chairman, Dept. of Agronomy, BAC, Sabour

Weed management in ZT crops

- ✓What is weed?
- ✓Agronomic management
- ✓Different types of weeds
- ✓Chemical control

What is Weed?

Any vegetation interfering crop production, competing with crop for natural recourses, ultimately reduces productivity and quality of crop.

- Average yield loss – 30-35%
- Rabi- about 25 %
- Kharif- about 35-37%

Agronomic management for controlling weeds

- Use of healthy and clean crops seed
- Destroy the weeds before sowing
- Variety- initial fast growth
- Crop rotation and intercropping
- Irrigation method- prefer drip irrigation
- Mulching
- Solarization

Different weeds

- **Kharif**
  - Broad leaf – Phylanthus, Euphorbia, celosia, Ageratum, Commelina
  - Narrow leaf – Echinochloa, Digitaria, Cynodon, Eleusine
- **Rabi-**
  - Broad leaf- Chenopodium, Anagallis, Convolvulus, Euphorbia, Rumax, Vicia, Melilotus
  - Narrow leaf- Phalaris, Cynodon,, Avena, Polypogon

Sedges- Cyperus

Weed management in rice

Herbicides	Rate (a.i. gram/ha)	Product rate(g or ml/ha)	Application time
Pretilachlor	750	1500	2-4 Days after sowing
Bispyribac sodium	25	250	15-25 DAS for controlling BL, NL and sedges
Azimsulfuron	35	70	15-25 DAS, control BLW and Sedge
Halosulfuron	67	89	15-25 DAS, control BLW and Sedge
Ethoxysulfuron	18	120	25-30DAS, Control BLW and sedges

Weed management in wheat

Herbicides	Rate (a.i. gram/ha)	Product rate(g or ml/ha)	Application time
Pendimethalin	1000	3000	0-3 DAS
2,4-D Ethyl ester	400-600	1200	30-35 Days after sowing, BLW
Chlodinafop	60	400	30-35 Days after sowing, Narrow weed
Isoproturon	750-1000	1000-1250	30-35 Days after sowing, Narrow weed
Sulfosulfuron	25	33	25-30 DAS, control BLW and narrow

Weed management in maize

Herbicides	Rate (a.i. gram/ha)	Product rate (g or ml/ha)	Application time
Pendimethalin	1000	3000	0-3 DAS
Atrazine	750-1000	1500-2000	0-3 DAS
Tembotrione	120	349	15-25 Days after sowing, Grass and BLW
Halosulfuron	90	120	15-25 Days after sowing, Sedges and BLW

Weed management in pulses

Herbicides	Rate (a.i. gram/ha)	Product rate (g or ml/ha)	Application time
Pendimethalin	750-1000	2500-3000	0-3 DAS
Quazilofop ethyl	40-50	800-1000	15-25 DAS
Imazethapyr	40-60	400-600	30 DAS

Weed management in oilseeds

Herbicides	Rate (a.i. gram/ha)	Product rate (g or ml/ha)	Application time
Pendimethalin	750-1000	2500-3000	0-3 DAS
Quazilofop ethyl	40-50	800-1000	15-25 DAS
Imazethapyr	60-80	600-800	30 DAS, especially in soybean and groundnut
Imazethapyr + Imazamox	80-100	800-1000	25-35 DAS, especially in soybean and groundnut

W03L04: Nutrient Management

Dr. Sanjay Kumar
Chairman, Dept. of Agronomy, BAC, Sabour

Nutrient Management

✓Diagnosis of nutrient deficiency

✓Decision making tools (Greenseekers/Leaf colour chart/Nutrient expert

Deficiency symptoms

- ✓ **Nitrogen (N) deficiency:** yellowing of the leaves start showing in the older leaves near the base of the plants. If the condition persists, these leaves become completely yellow and fall off from the plants.

- ✓ **Phosphorus (P) deficiency:** P deficiency does not turn the leaves into yellow colour. Leaves turn dark green and even purple colour from the margins. The petioles also turn red-purplish colour.

Deficiency Symptoms

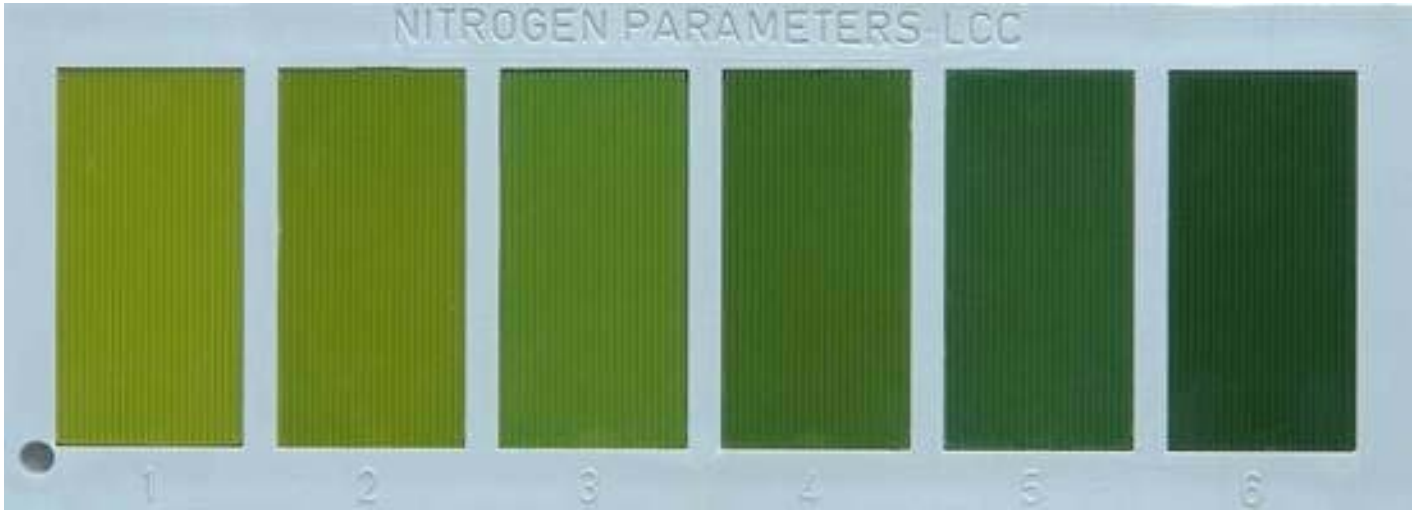
- **Potassium (K) deficiency:** leaves margins and tips turn yellow and rusty and may also curl and crinkle from the older leaves. Stem branches may increase and plants become slender and weak.

- **Sulfur (S) deficiency:** young leaves turn yellow and plants become short and small. Similar to nitrogen deficiency but starts with the younger leaves.

Leaf Colour Chart

- The Leaf Colour Chart (LCC) is used to determine the N fertilizer needs of the crop. LCC has four to six green strips, with colour ranging from yellow green to dark green.

- It determines the greenness of the rice leaf, which indicates its N content.



GreenSeeker

The GreenSeeker handheld crop sensor is an affordable, easy-to-use measurement device that can be used to assess the heath or vigour of a crop for better nutrient management decisions.

Nutrient Expert

Nutrient Expert is an easy-to-use, interactive, and computer-based decision support tool that can rapidly provide nutrient recommendations for an individual farmer field in the presence or absence of soil testing data.

W03L05: Water Management

Dr. Sanjay Kumar
Chairman, Dept. of Agronomy, BAC, Sabour

Water Management

- ✓Problems in water management
- ✓Benefits of irrigation
- ✓How much to irrigate?
- ✓Water use efficiency
- ✓When to irrigate?

Problems in Water Management

- ✓ Loss of water through evaporation and run-off
- ✓ How much and when to irrigate crops?
- ✓ What will be the cropping system and crop planning?

Benefits of Irrigation

- Increases productivity
- Three to four crops in a year
- Helps against problematic soil
- Water saving

How much to irrigate?

- Soil physical condition
- Soil fertility
- Moisture content in soil
- Water table
- Quality of irrigation water
- Crops and their rooting behaviour

Increasing water use efficiency

- ✓ Land leveling
- ✓ Good irrigation method
- ✓ Good agronomic management (Weeding, mulching)
- ✓ Drainage facility
- ✓ Short duration crops
- ✓ Low water requiring crops

When to irrigate?

- ✓ Plant indices
- ✓ Feel and appearance method
- ✓ Indicator plants
- ✓ Soil-cum-sand miniplot technique
- ✓ Sowing high seed rate
- ✓ Critical stage approach
- ✓ Climatological approach
- ✓ Tensiometer
- ✓ Infrared thermometry
- ✓ Remote sensing

Course Name: Conservation Agriculture based Sustainable Intensification
Week 03-Lecture-1: Land Preparation
Course Instructor: Dr. Sanjay Kumar, Chairman, Dept. of Agronomy, BAU, Sabour

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.

Course Name: Conservation Agriculture based Sustainable Intensification
Week 03-Lecture-2: Herbicides application
Course Instructor: Dr. Sanjay Kumar, Chairman, Dept. of Agronomy, BAU, Sabour

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 non-selective 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.

Course Name: Conservation Agriculture based Sustainable Intensification
Week 03-Lecture-3: Weed management for ZT crops
Course Instructor: Dr. Sanjay Kumar, Chairman, Dept. of Agronomy, BAU, Sabour

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.

Course Name: Conservation Agriculture based Sustainable Intensification
Week 03-Lecture-4: Nutrient Management
Course Instructor: Dr. Sanjay Kumar, Chairman, Dept. of Agronomy, BAU, Sabour

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.

Course Name: Conservation Agriculture based Sustainable Intensification
Week 03-Lecture-5: Water Management
Course Instructor: Dr. Sanjay Kumar, Chairman, Dept. of Agronomy, BAU, Sabour

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