This manual is designed to assist you to prepare for the training, guide you step by step during the training and give you handy information about each topic when you need it. The manual is an integral part of the training system which includes –

A. Flipfiles for ISFM and BMP of each agricultural product

B. Games and activities

C. Demonstration material

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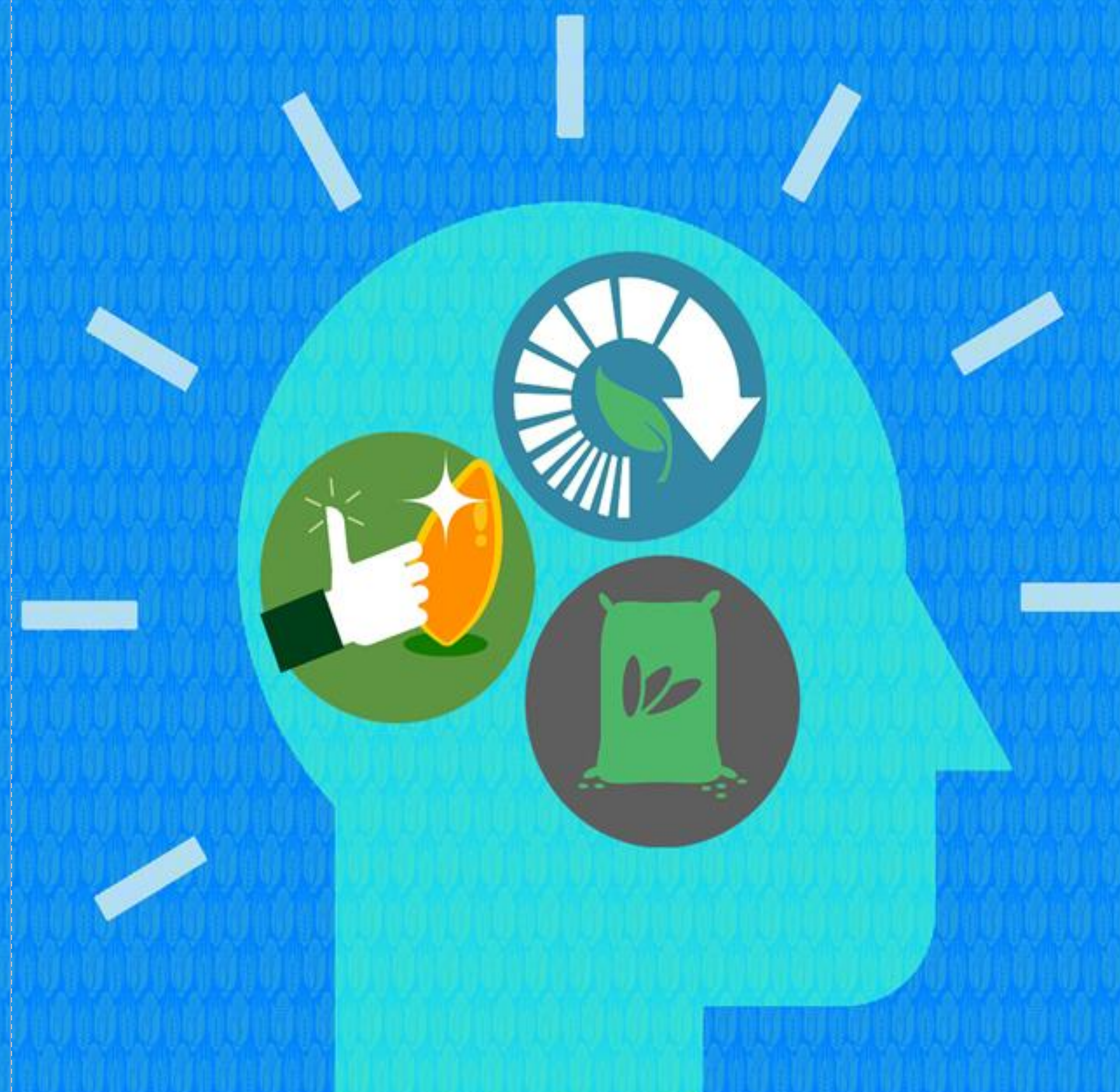
TRAINER'S MANUAL - ISFM



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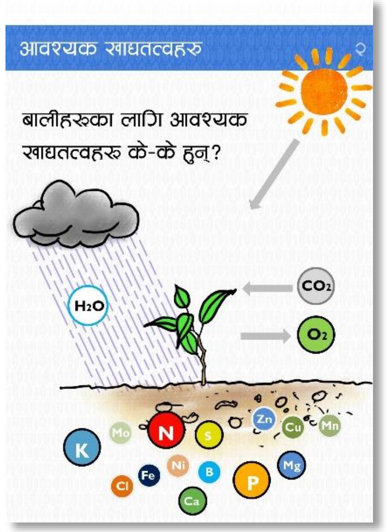
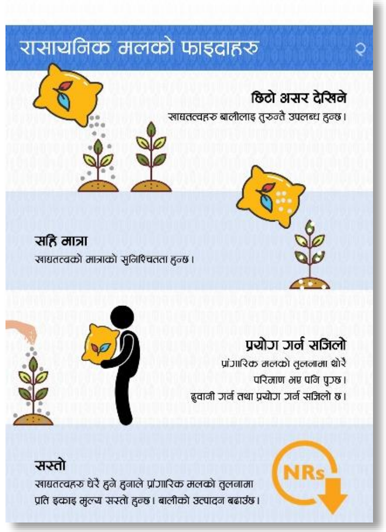
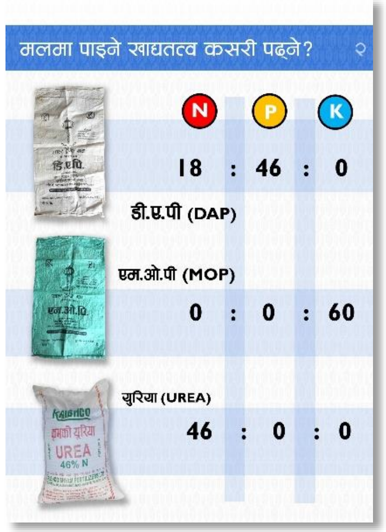
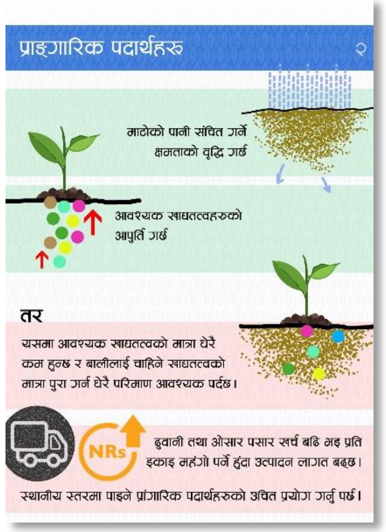
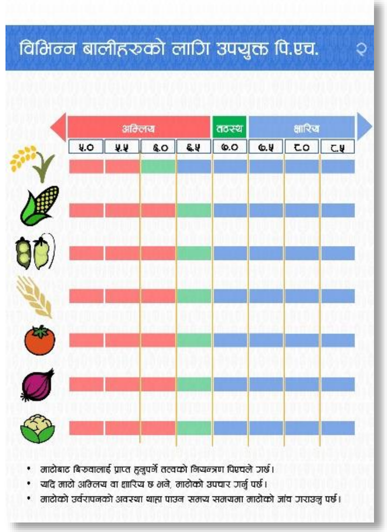
OVERVIEW OF THE FLIP FILE











LIST OF ACTIVITIES AND MATERIAL USED

ACTIVITY 1 – MARKET GAME

1. 3 Tables – Market, Green Team, Blue Team written on those.
2. 2 sets of Crop Cards – Green and Blue, 10 each
3. 1 set of 40 Cash Cards
4. 2 sets of Ingredient Cards – Labor, Seed, Water and Fertilizer.

ACTIVITY 2 – PRE-TEST

1. Answer sheets, at least 30% more then the number of participants.
2. Pens for participants

ACTIVITY 3 – PYRAMID OF ELEMENTS

1. 10 x10 cm for N, P, K;
2. 6 x 6 cm for Ca, Mg, S, and
3. 4 x 4 cm for Zn, B, Mo, Fe, Cu, Cl, Mn, Ni
4. 3 white board (30 cm x 45 cm) for three groups to prepare pyramid of the cards and
5. 3 small tables to display the pyramids

ACTIVITY 4 – DISPLAY OF SOIL NUTRIENTS

ACTIVITY 5 – LEAKING BUCKET

1. Nutrient bucket (10 L) with 14 holes of about 1 cm diameter at different heights to indicate imbalance nutrient levels (availability) in the soil
2. Each hole fitted with a stopper 'to close and open' marked for a different nutrient (assume that the bucket is a farmer field and the holes are requirement levels of nutrients in the soil/field)
3. Each hole represents a particular nutrient (nutrient symbol should be written on the rubber plug or on a waterproof tag for each of the plugs)
4. A bowl, big enough to hold the bucket in it
5. A smaller bowl with flat base, as stand of the bucket
6. Water enough to overfill the bucket
7. Jug and bucket for water
8. A table on which demo will be conducted

ACTIVITY 6 – SOF BALANCE

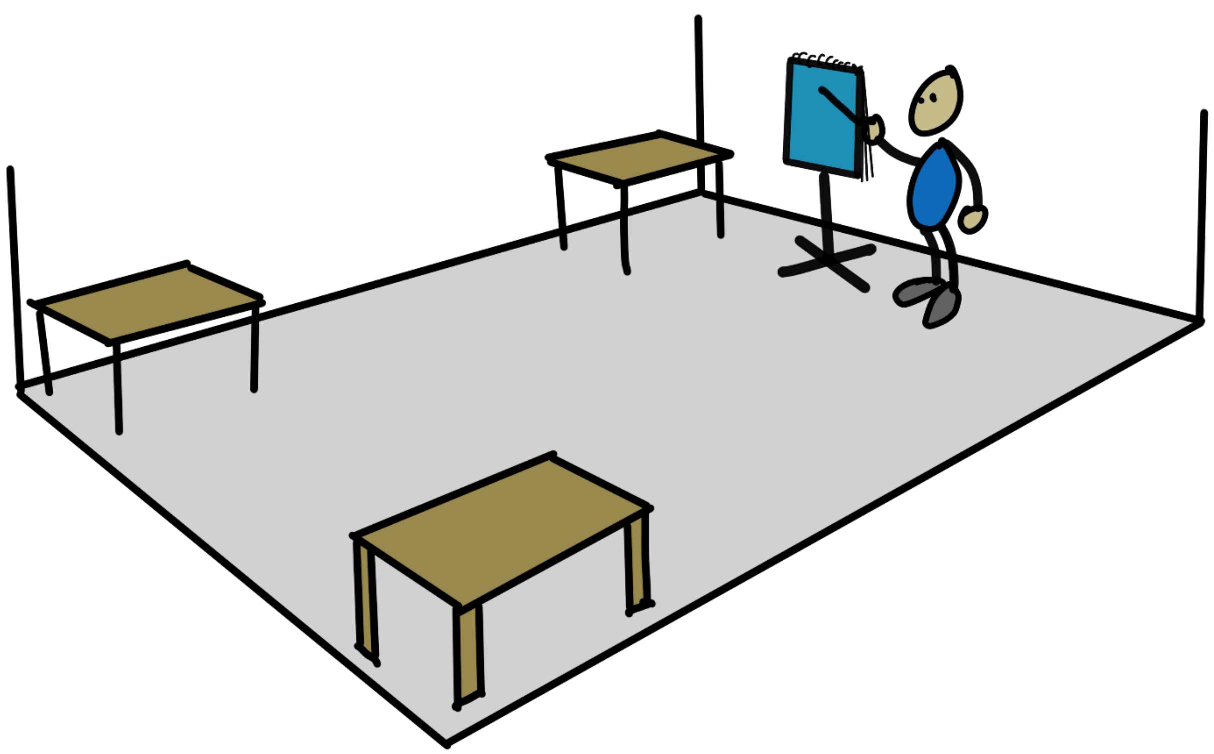
1. Transparent water bowl.
2. Three legged bowl stand with one let detachable.
3. Water.

HOW TO PREPARE FOR THE ACTIVITIES?

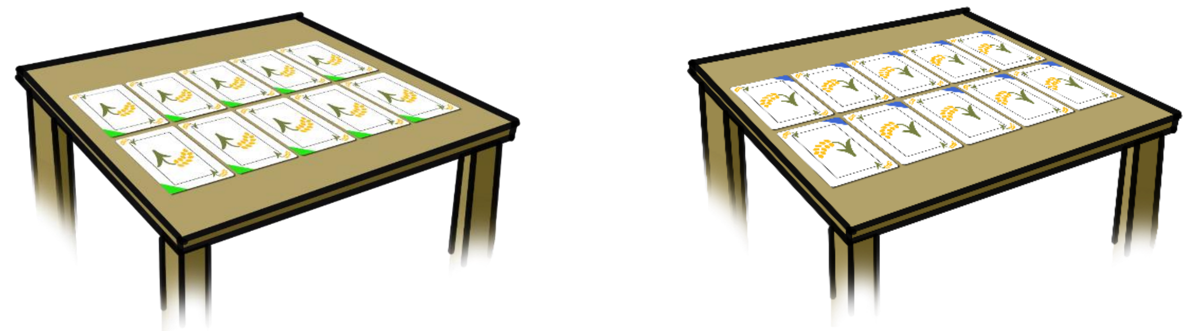
ACTIVITY – MARKET GAME

THE INTENT of this game is to explain to participants that every time they sell their produce to the market, they also sell Water, Seed, Labor and Fertilizer along with it, and they need to replenish this. Also the fact that saving money by not buying fertilizers will leave the farmer poorer in long run.

Before you start the session, even before the participants are seated, you should arrange three small tables or 3 marked square spaces on the floor away from one another. If you plan to arrange this on floor, you can do this by placing three big sheets of paper on the floor. These three areas symbolize a market area and two fields for the crop you are conducting the training for.



The Market - The trainer or the training assistant plays the role of Business – i.e. the buyer of cultivated crop AND the seller of - Water, Seed, Labor and Fertilizer. On a paper, write 'market' and place it at the edge of this area. The business has a bundle of Cash Cards, and cards that sell Water, Seed, Labor and Fertilizer. These are kept hidden.



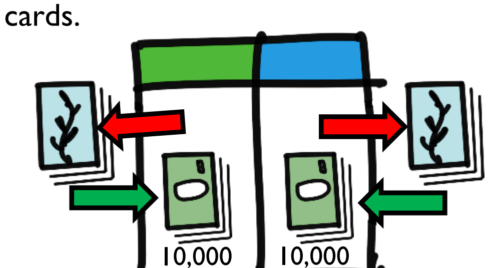
Crop Fields -There are two teams of farmers – Green and Blue. Place 10 cards of the crop on each of the fields. The cards have green and blue at the corners. Make sure that 4 of the cards on each area show – Water, Seed, Labor and Fertilizer on the flipside. Remember that these 4 elements are hidden from the participants and you need to make sure the participants are not able to see the flipside of the cards at the beginning of the game.

STEPS:

1. Separate the participants into 2 teams – green and blue. Tell them that the green field belongs to the green team and blue field belongs to the blue team and the participants can go and stand next to their respective fields.

2. Ask the teams to collect (harvest) their crop (cards) and go to the market one by one and sell it. Make sure the teams do not flip their cards.

3. Since each team had 10 units of crop, both get equal amount of money from the market. For e.g. 10 Cards X NRs 1000 = 10,000 NRs. Both teams return to their fields.



4. Ask the teams - 'How much money do you have?' and note it on the whiteboard under their names.

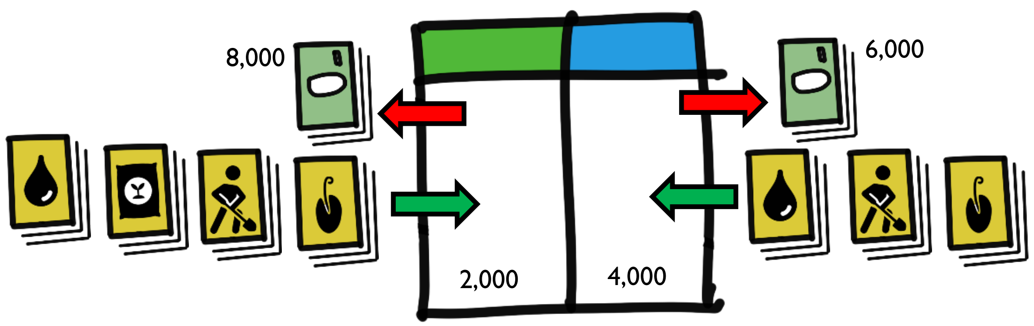
5. Walk up to the white board/ paper sheet and ask 'Now that you have money from the crop, you have to plan for the next crop. What would you need to buy for the next crop?'

6. You may prompt the participants and write - Water, Seed, Labor and Fertilizer on the white board.

7. Tell the participants that – Well then you have money from the last crop, go to the market one by one and buy what you need.

HOW TO PREPARE FOR THE ACTIVITIES?

8. The 'market' has only 7 cards -2 each of Water, Seed, and Labor and one of Fertilizer at cost of NRs 2000 each. Thus one the teams comes back without Fertilizer.

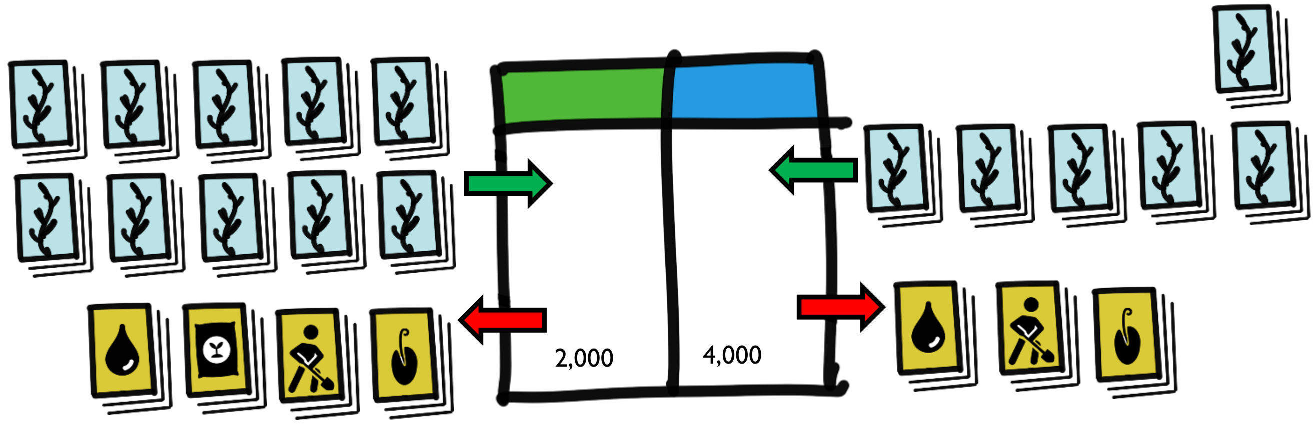


9. Pause here, and ask the teams 'How much money do you have left?'. The team which did not get fertilizer should have NRs 4000 and the one which got the fertilizer should have NRs 2000. Write this down on the white board under their names.

10. Trainer may joke with teams and call the team with more money 'Big/ Rich people'.

11. Ask the teams to 'apply' (place) these products on to their fields and wait for the crop to grow.

12. Trainer walks up to each field and places 2 cards of crop for each of Water, Seed and Labor and 4 cards for the Fertilizer. Thus, one of the teams get 3X2= 6 Crop Cards and the other gets 3X2=6 +4=10 Crop Cards. Make sure you take the Water, Seed, Labor and Fertilizer cards back as they have been consumed growing the crops.



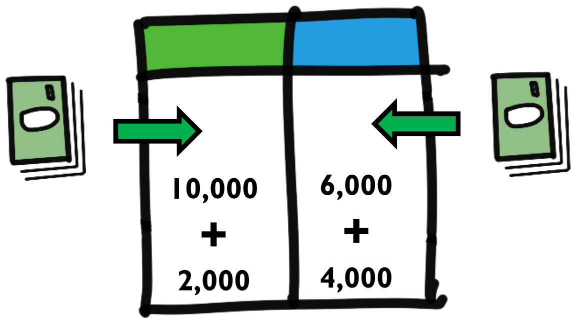
13. In effect this means that one of the teams will 'grow' 6 units and the other will grow 10 units of the crop.

13. Ask the teams to go to the market again and sell their produce.

14. The team with 6 units of crop gets NRs 6000 and one with 10 gets NRs 10,000. Write this down under their names.

15. *Team with no fertilizer were left with NRs 4000, the 2nd time, this team got NRs 6000. Thus left with cash in hand of NRs 10,000.*

16. *The team with fertilizers were left with NRs 2000, and the 2nd time they got NRs 10,000 bringing their total cash in hand to NRs 12,000.*



17. The trainer walks up to the market place, picks up the cards of the first crop sold to the market and flips them over to show that – When you sold the first crop, you did not realize that you sold Water, Seed, Labor and Fertilizer with it. But when you go to shop before the next crop, if you do not buy fertilizer, you are not given the soil back what you took from it. Thus, making it weaker to give you money.

18. Make the 2nd point – In short term, although one team might feel that they are richer but as you saw, in long run, the other team, who used fertilizers is rich. So if you are rich, and the soil is getting poorer, you are poor.

HOW TO PREPARE FOR THE ACTIVITIES?

ACTIVITY – PRE-TEST

THE INTENT of this activity is to assess the knowledge of participants in the area of soil and fertilizer management. This assessment will be later compared with the assessment of post-workshop-test.

A. You may distribute these forms just before first Tea time. Ask participants to assemble after 20 minutes.

B. Ask volunteers from participants to distribute and collect the answer sheets. Leg work keeps the workshop alive and enhances the emotion of ownership.

C. Take a walk around the participants and make sure that participants are sitting away from one another when they answer this test.

D. Being illiterate doesn't amount to having no knowledge. Provide an assistant to those who can't read and write. The trainer, the training assistant or those wh have finished their test early may assist.

E. But make sure that the one assisting writes only the answers given by the participant.

F. Provide extra time for those who can't read and write.

ACTIVITY – PYRAMID OF ELEMENTS

THE INTENT of this game is to prove that all the elements necessary for the soil to give farmers a good yield are EQUALY important. Removal of even one element from the soil will lead to misbalance in the health of the crop.

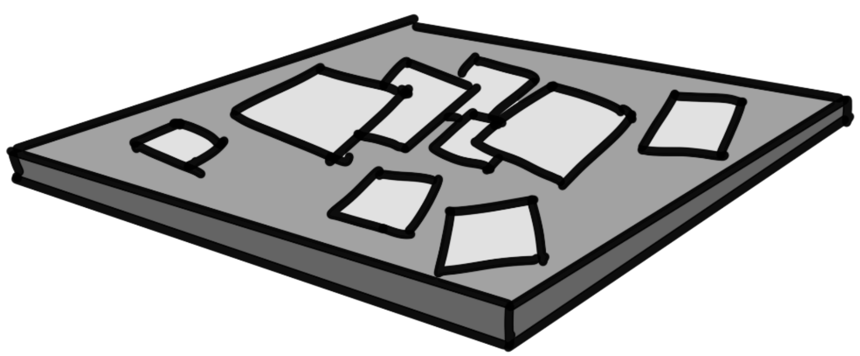
A. About 10 minutes before you reach this point, ask Training Assistant to prepare for this game.

B. This game consists of a slippery surface and 14 hard box cards of 3 different sizes, in 2-3 sets (depending on number of participants) set on 2-3 separate tables/ space on the floor.

C. Make sure that the assigned spaces are at a good visual distance away from one another (so that the participants cannot cheat).

D. The slippery surface has to be a sun mica board or a very strong cardboard. This will have to be lifted from one side during the game.

E. Before the game starts, the hard box cards are placed randomly over the slippery surface with the BLANK SIDE FACING UP.

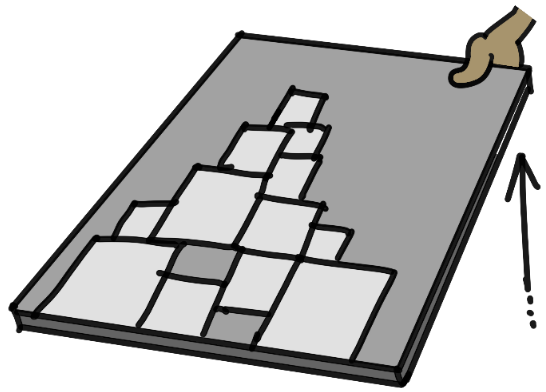


STEPS:

1. Arrange the participants in teams not more then 4-5 member each. If there are too many participants, add another set for the game. For e.g. if there are 13 participants, arrange for 3 sets.

2. Ask each team to arrange the hard cards on the board in such a way that the overall form is closer to that of a pyramid or a triangle and it should look sturdy. Provide 10 minutes for this.

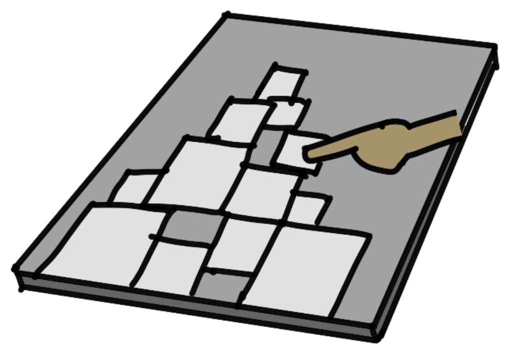
HOW TO PREPARE FOR THE ACTIVITIES?



3. Suggest that every member of the team participates in this and they may choose a person who will move the boxes around.

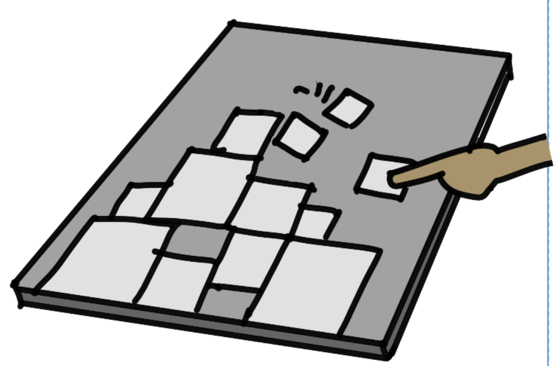
3. After 10 minutes ask participants to stop and walk to each team and lift the board from the top to a 45 degree and let the team watch if their structure collapse or not.

4. Having done this with all the teams, pick any of the structures and ask everyone to assemble around it.



5. Lift the board from one side and tell the participants – All the boxes, small or big, when arranged in an order creates a strong structure.

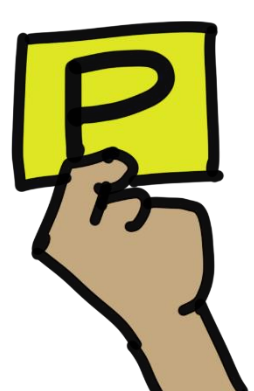
6. Put your finger on one of the boxes at the edge of the structure and move it out of the structure. The structure will come crashing down and some of the boxes, after falling off will reveal the other side.



7. Address the participants – When even one, even small part of the structure is taken out, it comes crashing down.

8. Show the participants the other side of all the box cards and say 'These are the elements a healthy soil MUST have. However when even one element is removed, the soil is not strong enough to make a good crop.

9. Lift each card and ask participants to try to recognize what chemical symbol that is.



10. Tell participants what benefit each element brings to the soil and to the crop.

ACTIVITY – DISPLAY OF SOIL NUTRIENTS

THE INTENT The intent is to familiarize the participants with touch, feel and look of elements that are found in Soil or are added to it to strengthen its fertility.

A. Display the material in a row. Make sure that that you choose a contrasting color container i.e. for white material choose a black plate.
B. Let participants walk past in a line and let them take their time smelling and touching the material.

HOW TO PREPARE FOR THE ACTIVITIES?

ACTIVITY – LEAKING BUCKET

THE INTENT of this demonstration is to emphasize the fact that removal (or absence) of even one element from the soil will reduce the effectiveness of all other elements and until the removed element is replaced, there is really no point adding other elements to the soil.

A. Ask training assistant to prepare for this demonstration a 10 minutes ahead away from the class where spilling of water doesn't spoil anything.

B. Place the bucket in a shallow tub on the top of a table and fill water into the bucket at least up till the top stopper. Keep another bucket filled with water to be used during the demonstration.

STEPS:

1. Ask participants to assemble around the table in a semi-circle so that they all can see what is about to happen.

2. Stay on the side of the table and remove the stopper 2nd from the top. The water will come gushing out down until the level of 2nd hole.

3. Tell the participants that you removed the 2nd stopper but the water is removed from behind the first stopper as well.

4. Tell the participants that you are going to try to fill in for the first stopper. Pick the 2nd bucket up and fill the first bucket to the brim. (participants may laugh at you at this point) The water will still spill out until the 2nd hole.

5. Make your point – So, no matter how much I try to put in the first element, until the time I put back in the 2nd element, there is no point me trying to fill in the first element.

6. To make your point further, plug out the stopper for 6th or 7th element – See, when I plug out 6th element, there is no point in my putting 1st to 5th element in to the soil. Thus, every element has a specific role to play for the bucket to be full as is in the case of 'soil to be fertile' and no matter how much you try to substitute one element with another, it's not going to work.

ACTIVITY – SOF BALANCE

THE INTENT of this demonstration is to explain that the nutrients provided by the soil, the organic material and the chemical fertilizers need to be in a perfect balance for the overall health of the soil. This demonstrations also symbolizes what ISFM stands for.

For the demo, you have a wooden tripod (3 legs) with circular base to for a transparent glass pot to be kept on. The 3 legs of the stand symbolize- Soil, Organic Material and Chemical Fertilizers

STEPS:

1. Start your demo with the fertilizer leg taken half out and the pot filled with water to the maximum possible level.

2. Talk to the participants – You see, there is a shorter leg and thus the pot is tilted. That is why we cannot fill it to the brim. Is there a way by which we can fill the pot to the brim?

3. Let participants discuss and come up with an answer – 'Yes. Make all legs equal.'
4. Ask – "So, are you saying all three legs need to be equal for us to maximize the capacity of this pot?' You will get the answer – 'Yes!'

5. Make your point – Similarly, Soil, Organic Material and Chemical Fertilizers have to be in perfect balance for you to get maximum yield from the soil.

6. Put the wooden piece into the smaller leg to make it equal, and fill in the water into the pot to the brim. 'This is how!'

HOW DOES THIS MANUAL WORK?

The manual is designed in such a way that you can have it open in front of you while running a training and it will guide you through each step as you move forward. The manual is laid out in such a fashion that when you flip the pages of flipfile, all you need to do is flip the page of the manual to see the instructions for that specific page of Flipfile, and that step of training.

ON THE PAGE ON YOUR LEFT HAND

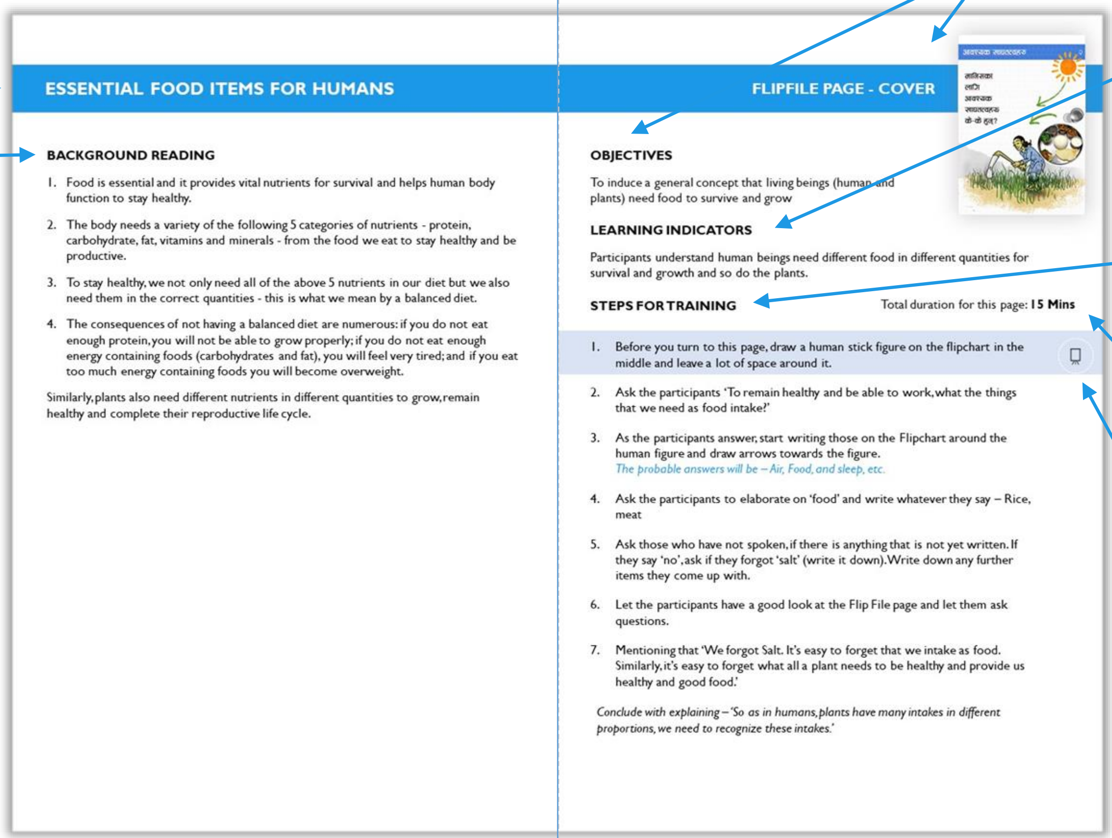
You will see the subject on the top, this is also the subject of the flipfile page that you will train in.

Below this, we have provided you with the 'Background Reading'. This is slightly more detailed information regarding the subject matter that you must know, in case further questions are asked by the participants. We suggest you read up the left hand side pages of the training manual carefully a day before holding the workshop.

ON THE PAGE ON YOUR RIGHT HAND,

we have given you all the steps that you need to follow, while a specific page of the flipfile is being trained from.

- At the top right corner of the page, you will see a small picture and number of the flipfile page that is currently being trained from.
- You will find the objective of the training of the specific page of the flipfile.
- In 'Learning Indicators' you will see – what should you look for to find if the participants have understood the subject addressed in the flipfile page.
- You will see the steps that you need to follow to accomplish the training for the specific FlipFile page.
- An indicator of suggested duration of training of current flipfile page.
- At the right edge of the page you will sometimes see an icon. This icon is a quick reminder of the objects that you need to use at that step of the training. These important steps are market with light blue box underneath.


ESSENTIAL FOOD ITEMS FOR HUMANS

BACKGROUND READING

1. Food is essential and it provides vital nutrients for survival and helps human body function to stay healthy.
2. The body needs a variety of the following 5 categories of nutrients - protein, carbohydrate, fat, vitamins and minerals - from the food we eat to stay healthy and be productive.
3. To stay healthy, we not only need all of the above 5 nutrients in our diet but we also need them in the correct quantities - this is what we mean by a balanced diet.
4. The consequences of not having a balanced diet are numerous: if you do not eat enough protein, you will not be able to grow properly; if you do not eat enough energy containing foods (carbohydrates and fat), you will feel very tired; and if you eat too much energy containing foods you will become overweight.

Similarly, plants also need different nutrients in different quantities to grow, remain healthy and complete their reproductive life cycle.

FLIPFILE PAGE - COVER

OBJECTIVES

To induce a general concept that living beings (human and plants) need food to survive and grow

LEARNING INDICATORS

Participants understand human beings need different food in different quantities for survival and growth and so do the plants.

STEPS FOR TRAINING

Total duration for this page: **15 Mins**

1. Before you turn to this page, draw a human stick figure on the flipchart in the middle and leave a lot of space around it.
2. Ask the participants 'To remain healthy and be able to work, what the things that we need as food intake?'
3. As the participants answer, start writing those on the Flipchart around the human figure and draw arrows towards the figure.
   The probable answers will be – Air, Food, and sleep, etc.
4. Ask the participants to elaborate on 'food' and write whatever they say – Rice, meat
5. Ask those who have not spoken, if there is anything that is not yet written. If they say 'no', ask if they forgot 'salt' (write it down). Write down any further items they come up with.
6. Let the participants have a good look at the Flip File page and let them ask questions.
7. Mentioning that 'We forgot Salt. It's easy to forget that we intake as food. Similarly, it's easy to forget what all a plant needs to be healthy and provide us healthy and good food.'

Conclude with explaining – 'So as in humans, plants have many intakes in different proportions, we need to recognize these intakes.'

ACTIVITY – MARKET GAME

OBJECTIVES

To explain to participants that every time they sell their produce to the market, they also sell Water, Seed, Labor and Fertilizer along with it, and they need to replenish this. Also the fact that saving money by not buying fertilizers will leave the farmer poorer in long run.

LEARNING INDICATORS

Participants understand that saving money on fertilizers, in long run, will actually cause harm to the soil and future economic well being.

STEPS:

1. Arrange three small tables or 3 marked square spaces on the floor away from one another. If you plan to arrange this on floor, you can do this by placing three big sheets of paper on the floor. These three areas symbolize a market area and two fields for the crop you are conducting the training for.

2. Separate the participants into 2 teams – green and blue. The participants can go and stand next to their respective fields.

3. Ask the teams to collect (harvest) their crop (cards) and go to the market one by one and sell it. Make sure the teams do not flip their cards.

4. Since each team had 10 units of crop, both get equal amount of money from the market. For e.g. 10 Cards X NRs 1000 = 10,000 NRs. Both teams return to their fields.

4. Ask the teams - 'How much money do you have?' and note it on the whiteboard under their names.

5. Walk up to the white board/ paper sheet and ask 'Now that you have money from the crop, you have to plan for the next crop. What would you need to buy for the next crop?'

6. You may prompt the participants and write - Water, Seed, Labor and Fertilizer on the white board.

7. Tell the participants that – Well then you have money from the last crop, go to the market one by one and buy what you need.

NOTES

9. The 'market' has only 7 cards -2 each of Water, Seed, and Labor and one of Fertilizer at cost of NRs 2000 each. Thus one the teams comes back without Fertilizer.

10. Ask the teams 'How much money do you have left?'. The team which did not get fertilizer should have NRs 4000 and the one which got the fertilizer should have NRs 2000. Write this down on the white board under their names.

11. Ask the teams to 'apply' (place) these products on to their fields and wait for the crop to grow.

12. Trainer walks up to each field and places 2 cards of crop for each of Water, Seed and Labor and 4 cards for the Fertilizer. Thus, one of the teams get 3X2= 6 Crop Cards and the other gets 3X2=6 +4=10 Crop Cards. Make sure you take the Water, Seed, Labor and Fertilizer cards back as they have been consumed growing the crops. This means that one of the teams will 'grow' 6 units and the other will grow 10 units of the crop.

13. Ask the teams to go to the market again and sell their produce.

14. The team with 6 units of crop gets NRs 6000 and one with 10 gets NRs 10,000. Write this down under their names.

15. *Team with no fertilizer were left with NRs 4000, the 2nd time, this team got NRs 6000. Thus left with cash in hand of NRs 10,000.*

16. *The team with fertilizers were left with NRs 2000, and the 2nd time they got NRs 10,000 bringing their total cash in hand to NRs 12,000.*

17. The trainer walks up to the market place, picks up the cards of the first crop sold to the market and flips them over to show that – When you sold the first crop, you did not realize that you sold Water, Seed, Labor and Fertilizer with it. But when you go to shop before the next crop, if you do not buy fertilizer, you are not given the soil back what you took from it. Thus, making it weaker to give you money.

18. Make the 2nd point – In short term, although one team might feel that they are richer but as you saw, in long run, the other team, who used fertilizers is rich. So if you are rich, and the soil is getting poorer, you are poor.

INTRODUCTION TO THE WORKSHOP

INTRODUCTION (no FF is used for this)

In the beginning of the training session, welcome the participants (and introduce yourself (trainer) with name, position/responsibility, place of ... more things …….., if you think this will help create a positive environment in the training place.
Ask your colleague and participants to introduce themselves individually one by one.

After introduction restart and introduce the TOF with the following points

- Integrated soil fertility management (ISFM) is an approach to increase crop yield and profit of farmers while increasing and maintaining soil fertility.
- ISFM justifies use of suitable seed, adequate organic matter and balanced fertilizers tested and adapted in local conditions
- Nepal Seed and Fertilizers Project (NSAF) has been testing and recommending suitable package of 'best management practices' (BMP) of rice to increase yield and net profit of farmers while better managing soil fertility
- This TOF, considering the above mentioned realities, consists of a package of practices BMP rice adapted in Nepalese conditions with ISFM

There are two parts of TOF
Basic concept of ISFM – when OM, seed and fertilizers are adapted together in farmer's conditions - they contribute much better yield results than what they could have contributed individually
BMP of rice: The ISFM is incorporated in every step package of practices of rice production, including variety selection; management of OM, fertilizer and farm resources; nursery raising; transplanting; crop management, harvesting processing and storage

Objectives
The overall objective of TOF is to capacitate intermediaries to help deliver ISFM skills and logistics to a large number of farmers, so that there is more crop production and higher net benefits to the farmers while maintaining and promoting soil fertility.
The immediate objectives are:
1. Provide TOT on ISFM and BMP of crops to intermediaries
2. Strengthen business efficiency and motivational skills of intermediaries (so that they reach to larger number of the farmers and increase their own profit)
3. Agree plan of action with intermediaries to support farmers in field implementation of crop production with ISFM skills
4. Monitor and assess the process and report on the overall progress and learning for expansion of ISFM

ESSENTIAL FOOD ITEMS FOR HUMANS

BACKGROUND READING

1. Food is essential and it provides vital nutrients for survival and helps human body function to stay healthy.
2. The body needs a variety of the following 5 categories of nutrients - protein, carbohydrate, fat, vitamins and minerals - from the food we eat to stay healthy and be productive.
3. To stay healthy, we not only need all of the above 5 nutrients in our diet but we also need them in the correct quantities - this is what we mean by a balanced diet.
4. The consequences of not having a balanced diet are numerous: if you do not eat enough protein, you will not be able to grow properly; if you do not eat enough energy containing foods (carbohydrates and fat), you will feel very tired; and if you eat too much energy containing foods you will become overweight.

Similarly, plants also need different nutrients in different quantities to grow, remain healthy and complete their reproductive life cycle.

NOTES

FLIPFILE PAGE - 02

OBJECTIVES

To induce a general concept that living beings (human and plants) need food to survive and grow

LEARNING INDICATORS

Participants understand human beings need different food in different quantities for survival and growth and so do the plants.

STEPS FOR TRAINING

Total duration for this page: **15 Mins**

1. Before you turn to this page, draw a human stick figure on the flipchart in the middle and leave a lot of space around it.
2. Ask the participants 'To remain healthy and be able to work, what the things that we need as food intake?'
3. As the participants answer, start writing those on the Flipchart around the human figure and draw arrows towards the figure.
   The probable answers will be – Air, Food, and sleep, etc.
4. Ask the participants to elaborate on 'food' and write whatever they say – Rice, meat
5. Ask those who have not spoken, if there is anything that is not yet written. If they say 'no', ask if they forgot 'salt' (write it down). Write down any further items they come up with.
6. Let the participants have a good look at the Flip File page and let them ask questions.
7. Mentioning that 'We forgot Salt. It's easy to forget that we intake as food. Similarly, it's easy to forget what all a plant needs to be healthy and provide us healthy and good food.'

Conclude with explaining – 'So as in humans, plants have many intakes in different proportions, we need to recognize these intakes.'

ESSENTIAL PLANT NUTRIENTS

BACKGROUND READING

An element is called essential for plants when it is required by plants for **normal growth**, development and **completion of their life cycle.** An essential plant nutrient **cannot be substituted for** by other chemical compounds or elements.

The plants need 17 elements for their normal life cycle. Of these 17 nutrients, three (C, H and O) are provided by nature. The remaining 14 are called essential plant nutrients and supplied from the soil, fertilizers and organic manure.

The essential plant nutrients are divided into two groups: macro and micronutrients. Macro nutrients are again divided into primary and secondary nutrients.

The term macro and micronutrients used to refer relative quantity of nutrient requirement of crops. Macro nutrients are absorbed by plants in large amounts compared to micro nutrients. But, all nutrients are equally important for crop growth and development.

Macro and micronutrients: Primary nutrients: Nitrogen (N), Phosphorus (P), Potassium (K)

Secondary Nutrients: Calcium (Ca), Sulphur (S) and Magnesium (Mg)

Micronutrients are Zinc (Zn), Iron (Fe), Copper (Cu), Boron (B), Manganese (Mn), Molybdenum (Mo), Nickel (Ni), and Chlorine (Cl)

NOTES

OBJECTIVES

To make participants aware of essential plant nutrients and their importance

LEARNING INDICATORS

1. The participants know there are 17 essential nutrients required survival and growth of plants
2. C, H and O are available in abundance from nature (air and water)
3. Remaining 14 (N, P, K, S, Ca, Mg, Zn, Fe, Cu, Mn, B, Mo, Cl, Ni) come from soil, OM and fertilizers

STEPS FOR TRAINING

Total duration for this page: **15 Mins**

1. Ask the participants, do they know what are the essential plant nutrients?
2. Also as, do they know how essential nutrients are there and what are their categories?

Then, turn the page 2 of flip file and briefly explain the following

1. Count the element symbols (17)
2. Mention that Plants get C, H and O from air and water
3. The remaining 14 come from soil to plants
4. Tell to the participants that nutritional balance in all living beings – humans and plants works in the same way.
5. Also tell them that- the size of these elements in the flip file is not indicative of their importance
6. All the essential elements are equally important (as salt or butter in case of human food – they are small in quantity, equally important as other food items)

Stop the session

Ask them, let use play a game before we move to the next session (do not mention that it is related to what you have discussed just before this moment)

(Followed by Nutrient card game)

CARD GAME- ESSENTIAL PLANT NUTRIENTS

NOTES

OBJECTIVES

To make participants aware of essential plant nutrients and their importance

LEARNING INDICATORS

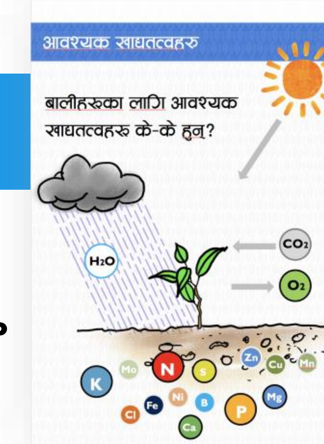
1. The participants know there are 17 essential nutrients required survival and growth of plants
2. C, H and O are available in abundance from nature (air and water)
3. Remaining 14 (N, P, K, S, Ca, Mg, Zn, Fe, Cu, Mn, B, Mo, Cl, Ni) come from soil, OM and fertilizers

STEPS FOR TRAINING

Total duration for this page: **15 Mins**

1. Divide the participants (+/- 15) into 3 groups
2. Show the white board and bundle of cars and explain that each group has to prepare a pyramid of the cards on the white board
3. Mention that the participants must not turn the card in the process of making pyramid.
4. Provide a set of 14 cards to each group with framed board to make pyramid (keeping the cards upside down, so that the trainees will not notice the nutrient symbols on the other side of the cards)
5. Ask each group to prepare pyramid of the cards on the board
6. Once the pyramids are ready, ask them to tilt the board up to 60^0 , the card will remain intact on the board (show one of the boards around the participants) and mention that the cards are arranged in balanced form, so supporting each other on the board
7. Take one of the white board and ask one participant to pull out one or two cards from the pyramid while holding the board at 60^0 or more (the balance will be lost and pyramid will fall)
8. The ask each group to sort out the cards in three categories according to the three sizes of the cards (the cards are yet to be turned upside down) and keep them on desk

NOTES



9. Take cards from one of the groups and turn the largest cards upside down and show them to the participants. They are **N, P and K**. Mention that N, P and K are the nutrients consumed by plants in the largest quantities and, that is why, these are called **primary nutrients** (repeat the statement and ask the participants for their confirmation)

5. Take the three cards of middle size and turn them upside down and show them to participants. They are **Ca, S and Mg**. Mentioned that these three nutrients are consumed less than the primary nutrients and more than the remaining 8 nutrients, that is why, they are called **secondary nutrients** (repeat the statement and ask the participants for their confirmation)

6. The primary and secondary nutrients are also called macro nutrients

7. Similarly, turn the set of 8 smallest cards and turn them one by one upside down showing them to participants. They are **Zn, Cu, Mn, B, Mo, Fe, Cl and Ni**. Mention that, in comparison to primary and secondary nutrients, these 8 nutrients are consumed in much smaller quantities by plants and, that is why, they are called micro nutrients (repeat the statement and ask the participants for their confirmation)

8. Conclude the session by mentioning that the requirement of plan for different nutrients differ in quantities, but all the essential nutrients are equally important for good crop production.

9. Also mention, requirement of one nutrients cannot be fulfilled by adequate application of other nutrients.

10. At this stage, ask your subordinate to prepare for bucket game –demo of Liebig's Law, which is next.

11. Invite questions for further clarity and ask questions

Q1:What are the three categories of plant nutrients?
A1: Primary macronutrients, secondary macronutrients, and micronutrients!

Q2:What are (some) the nutrients in each of the categories?
A2: N, P, K, (primary); Ca, Mg, S (secondary) and rest micronutrients

Q3:What is the difference between macro and micro nutrients?
A3: Only in the quantity, how much plants need, but not in the importance

LIEBIG'S LAW OF MINIMUM

BACKGROUND READING

1. The nutrients are complementary to each other and deficiency of any one limits use and efficiency of other nutrients, as well as growth and production of crop.
2. Many of these nutrients may be present in sufficient quantities in the soil or supplies through organic matters and mineral fertilizers, but only those that are limiting need to be added.
3. Yield-limiting nutrients may vary according domain, within domain farm to farm and even in farm plot to plot. The element that is in shortest supply (what is needed in proportion to other nutrients available) will determine the use and efficiency of the other nutrients.

Define Liebig's law of minimum:

'Different essential nutrient required by crop plants may be smaller or bigger in quantity, but all the essential nutrients are equally important for crop production. Adding anyone of them in excess cannot fulfill deficiency of others (only deficient nutrients should be applied to correct deficiency/requirement of the deficient nutrient).'

NOTES

OBJECTIVES

To make the participants aware of Liebig's Law of Minimum

LEARNING INDICATORS

The participants understand that:

1. Deficiency of one or more nutrients restricts efficiency of remaining nutrients
2. Use of balance dose of fertilizers is required for best results from available nutrients to the crops

BEFORE STARTING THE DEMO, discuss :

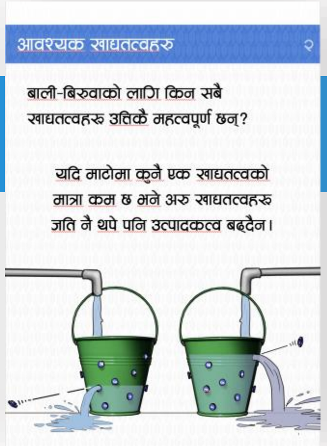
The nutrients are complementary to each other and deficiency of any one limits use and efficiency of other nutrients and growth and production of crop

1. Many of these nutrients may be present in sufficient quantities in the soil, but only those that are limiting need to be added.
2. Ask participants, what will happen when macro nutrients (NPK) are supplied in adequate quantities in which there is deficiency of Zn? Also ask, can one nutrient in excess meet the plant requirement for another nutrient (deficient)?

STEPS

1. Ask participants to assemble around the table in a semi-circle so that they all can see what is about to happen.
2. Stay on the side of the table and remove the stopper 2nd from the top. The water will come gushing out down until the level of 2nd hole.
3. Tell the participants that you removed the 2nd stopper but the water is removed from behind the first stopper as well.
4. Tell the participants that you are going to try to fill in for the first stopper. Pick the 2nd bucket up and fill the first bucket to the brim. (participants may laugh at you at this point) The water will still spill out until the 2nd hole.
5. Make your point – So, no matter how much I try to put in the first element, until the time I put back in the 2nd element, there is no point me trying to fill in the first element.

NOTES



6. To make your point further, plug out the stopper for 6th or 7th element – See, when I plug out 6th element, there is no point in my putting 1st to 5th element in to the soil. Thus, every element has a specific role to play for the bucket to be full as is in the case of 'soil to be fertile' and no matter how much you try to substitute one element with another, it's not going to work.

7. Flip over to the Flip File page at this time.

EXPLAIN LIEBIG'S LAW AS SHOWN IN THIS PICTURE ON THE FF PAGE

1. Mention that the bucket in the picture on the FF is crop field and the plugs symbols are the essential plant nutrients

2. Also mention that the water in the bucket is capacity of the field to produce crop

3. Indicate the hole mentioning that one of the nutrients is deficient in the field (Though other nutrients are there, but production is not increasing due to the deficient nutrient has made a hole to drain the production capacity of other nutrients even they are in adequate quantities).

4. Once that deficiency is fulfilled (the hole is plugged with a stopper) the production is increased only up to the level where another deficient nutrient is limiting the production beyond it

Discussion: Invite questions for further clarity and discussion

Summarize and conclude the session with: Based on the fertility status (soil analysis) and yield target, balance dose of fertilizers (nutrients) application is necessary for optimal yield and production (to compensate the nutrient limitations in the soil)

Ask questions

Q1: When is application of only DAP and urea not be sufficient?
A1: When there are other nutrients are deficient in the soil!

Q2: If there are other soil nutrient deficient in soil why is the use of only urea and/or DAP not enough for good yields?
A2: There are other deficient plant nutrients in the soil need to be added (the yield limiting nutrients) to make balance in soil nutrients!

Q3: How can you balance the nutrient requirements of a crop?
A3: Based on the soil analysis, fertilizer need is calculated according to the yield target, which may vary from domain to domain, within domain farm to farm and within farm plot to plot.

SOURCES OF PLANT NUTRIENTS

BACKGROUND READING

There ae mainly three sources of nutrients

1. Soil
2. Organic materials
3. Chemical fertilizers

1. Soil: Soil is a major source of nutrients for plants. Nutrients supplied by the soil are called mineral nutrients. Some soils are rich in plant nutrients while others are poor. In addition to NPK, other important **nutrients** are calcium, magnesium, sulfur and the micronutrients and they come from soil

Nutrients get into the soil through many different ways:

a. Decomposed animal waste and dead plants,

b. The atmosphere

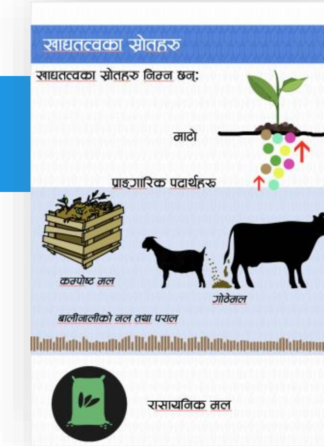
c. Weathering of rocks and bacteria conversions

- When **soils** are used to grow foods, the **soils** need to be kept healthy. A lot of **nutrients** are taken up from soils by plants and often not replaced.
- A low cation exchange capacity (CEC) soil has a low ability so store and/or supply nutrients to plants while a high CEC soil will have a high ability to store and/or deliver nutrients to plants.
- A loamy soil (a good mixture of sand, silt, and clay with a CEC between 10 to 14 or so) will have the best crop production.
- Soil texture is a major contributor to a soils ability to store and/or deliver nutrients to plants (soil fertility).

2. Organic matter: Organic nutrient sources are plant and animal wastes that are used as sources of plant nutrients. They release nutrients after their decomposition. Followings are some of the important organic nutrient sources:

- **Manure (dung) and urine:** Rich sources of nutrients, particularly N. Effective and efficient use of manure and urine increase crop productivity and soil fertility. They can be used in preparation of compost, farm yard manure and in biogas plant.

  Average percentage of nitrogen (N), phosphorus (P2O5) and potassium (K2O) in fresh excreta of farm animal



OBJECTIVES

To demonstrate that balance nutrient supply is must for optimal crop production

LEARNING INDICATORS

The participants understand that:

1. Deficiency of one or more nutrients restricts efficiency of remaining nutrients
2. Use of balance dose of fertilizers is required for best results from available nutrients to the crops

STEPS FOR TRAINING

Total duration for this page: **15 Mins**

1. Ask the participants, do they know what are the sources of plant nutrients? If they know, ask what will happen if one of the source is not available?
2. *Followed by calculation of nutrient supplied by MO and fertilizer*
3. Show an empty bag of urea and a commercial organic fertilizer (vermi-compost available in the market).
4. Ask participants to read the nutrient content of urea (46% N) and organic fertilizer (1.5 to 2.5% N).
5. Provide fertilizer price of urea (Rs 20/kg) and organic fertilizer (Rs 17/kg)
6. Give an example of nutrient requirement of rice, 60 kg N/ha
7. To supply 60 kg N, we need 130 kg urea or 4,000 kg organic fertilizer
8. Total fertilizer cost would be Rs. 2,600 for urea and Rs. 68,000 for organic fertilizer
9. Explain that organic fertilizer is beneficial, if it is produced within a farm (use of bought OM may be very costly, due to initial cost, handling, storage and application)
10. Replacement of chemical fertilizer with organic is not economic if it should be purchased.
11. BUT organic inputs are necessary for maintaining soil fertility

Excreta of		Nutrient content, %		
		N	P2O5	K2O
Cows and bullocks	Dung	0.40	0.20	0.10
	Urine	1.00	Trace	1.35
Goats and sheep	Dung	0.75	0.50	0.45
	Urine	1.35	0.05	2.10
Pig	Dung	0.55	0.50	0.40
	Urine	0.40	0.10	0.45

Crop residue: In addition to animal feed, crop residue can be incorporated in the soil to increase soil organic matter (SOM) and the supply plant nutrients for crop growth. Crop residues can also be used as mulch to retain soil moisture and control weed growth. Cycling crop residues through composting improves the availability of nutrients.

Nutrient contents of some crop residues

Straw or stalks of	Nutrient content, %		
	N	P2O5	K2O
Rice	0.36	0.08	0.71
Wheat	0.53	0.10	1.10
Maize	0.40	1.57	1.65

The best options for conserving nutrient stocks is to return or incorporate crop residues in the field or to use them as livestock fodder and recycle animal manure or to make compost for use in the cropping system. Therefore, it is important to recycle the plant residue in the soil rather than burning it

Organic Manure	Nutrient content, %		
	N	P2O5	K2O
FYM	0.5	0.2	0.5
Compost	0.5	0.15	0.5
Poultry Manure	1.1	0.8	0.5

Compost: Organic residues or a mixture of organic residues and soil which had been piled, moistened, and allowed to undergo biological decomposition, primarily from plant residues.

3. **Chemical fertilizer:** A **chemical fertilizer** is defined as any inorganic material of wholly or partially synthetic origin and contains more than 5% by mass of any combination of N, P and K. However, micro-nutrients, lime, gypsum and plant protection chemicals are also considered as fertilizers

Ask questions

Q1. What are the three sources of plant nutrients?
A1. They are soils, OM and fertilizers

Q2. What will happen if one of the sources is not available?
A2. The efficiency of nutrient supply and use of nutrients may be reduce, as well as crop yield and farmer's in come go down.

NOTES

WHAT IS ISFM?

BACKGROUND READING

1. Increased soil fertility and agricultural productivity can be achieved by adopting Integrated Soil Fertility Management (ISFM).

2. ISFM *is "A set of soil fertility management practices that necessarily include the use of fertilizer, organic inputs, and improved seed combined with the knowledge on how to adapt these practices to local conditions, aiming at optimizing agronomic use efficiency of the applied nutrients and improving crop productivity" (Vanlauwe B, Chianu J, Giller KE et al. 2010*).

3. ISFM increases crop productivity without depleting soil nutrients. ISFM is a combination of several techniques and activities where all inputs are managed following sound agronomic and economic principles.

4. Integrated Soil Fertility Management makes use of both organic and inorganic (fertilizers, chemical pest and disease controls) inputs and improved germplasm to improve the soil fertility and crop productivity, based on the local soil conditions. Inorganic inputs necessarily include mineral fertilizers and, depending on the local soil conditions, may include lime or gypsum.

The three major components of ISFM:

1. **Organic inputs** – very good for soil health and they also support better use of seed and fertilizers

2. **Improved seeds** – converter of nutrients and other inputs in grain and other forms of crop harvests

3. **Inorganic fertilizers** – best and cheapest source of nutrient with precise contents and quick effects

These three components are adapted in local conditions for optimal agronomic use efficiency together with 4Rs of fertilizer application (right source, right quantity, right time and right placement)

OBJECTIVES

To induce a general yet clear concept of ISFM in the participants

LEARNING INDICATORS

a) The participants know the three component of ISFM (seed, OM and fertilizers)

b) They also know that these three components must be adapted in local conditions for optimal crop production

STEPS FOR TRAINING

Total duration for this page: **15 Mins**

1) Ask participants, what are the components they use for crop production?

2) If they know, ask how they decide about use of these components in their farm?

3) Also ask, do they know all these components contribute use and efficiency of each other?

DEFINITION OF ISFM:

"A set of soil fertility management practices that necessarily include the use of fertilizer, organic inputs, and improved seed combined with the knowledge on how to adapt these practices to local conditions, aiming at optimizing agronomic use efficiency of the applied nutrients and improving crop productivity

Ask questions

Q1. What are the three major components of ISFM?
A1. The three major components of ISFM are OM, planting material and fertilizers.

Q2. When these three components of ISFM give optimal yield?
A2. When these components are adapted in the local conditions of farms.

TRIPOD CONCEPT OF ISFM

BACKGROUND READING

The ISFM concept is like a three-legged pot. Therefore, in the practice of ISFM, all the three components of organic inputs, inorganic inputs, and improved seeds must be present to hold the pot (production) on it.

1. If one leg of the tripod is unbalanced the other two may not hold pot on it
2. Locally adapted ISFM package is a combination of techniques where all inputs are managed following sound agronomic and economic principles
3. The forms and quantities of each component required depends on the local condition and may differ from one farm to another
4. In the practice of ISFM, there is no such thing as "one-size-fit-all". It is strictly site-specific.
5. At farm level, it is selection and use of 'best-fits' of resources and practices to the specific farm and, within farm, to the specific plots to minimize losses and increase benefits while sustaining productivity and soil health is called good agronomic practices
6. Good agronomic practices (GAP) mainly consist of:
   a. Right planting time
   b. Optimized planting densities
   c. Appropriate weeding
   d. Following the 4Rs of nutrient application
   e. Good plant protection practices
   f. Irrigation where appropriate
   g. Harvesting, processing and storage
7. The balanced and proportionally increased use of these ISFM components increases yield and net profit
8. The balanced and proportionally increased use of these ISFM components in local conditions increases yield and net profit

OBJECTIVES

To further consolidate the concept of ISFM among the participants

LEARNING INDICATORS

a) The participants know the three component of ISFM must be used in balanced quantities for optimal crop production

b) Proportional increase in use of these three components, adapted in local conditions, gives best crop yield and profit to farmers

TRAINING MATERIALS:

Bring two tripod and a pot (flat bottom) – one tripod with a broken leg and another with normal legs

STEPS FOR TRAINING

Total duration for this page: **15 Mins**

1) Put the pot one tripod with broken legs – does not hold the pot
2) Put the pot on the tripod with normal legs – it holds the pot
3) Conclude – to hold the pot (production) properly all the three legs of a tripod should be balanced

Ask for confirmation from the participants, if they agree

Ask questions

Q1. Why balanced use of ISFM components is important?
A1. The three ISFM components are just like three legs of a tripod. If any one leg of a tripod is unbalanced it cannot hold the pot on it. Similarly, unbalanced use of any component of ISFM will not produce good yield of crop.

Q2. How balanced use of ISFM components will increase crop production?
A2. The balanced and proportionally increased use of these ISFM components increases yield and net profit

MINERAL FERTILIZERS AND THEIR ADVANTAGES IN ISFM

BACKGROUND READING

Fertilizers are (inorganic) materials produced in factories containing more than 5% of any combination of N, P and K.

Micronutrients, lime, gypsum and plant protection chemicals are also considered as fertilizers

Advantages of Chemical Fertilizer:

1. Fast acting: fertilizers dissolve quickly and become available to plant
2. Precise content: Offers precise contents of nutrients
3. Knowing exactly what quantities is added to soil ensures correct nourishment of plants
4. Easy to use: Various formulations according to need, easy to transport, available in granules, soluble powder and tablets
5. Cost effective: Cheapest per unit of nutrient in comparison to organic manures

NOTES

OBJECTIVES

To provide basic knowledge and importance of fertilizer uses to participants

LEARNING INDICATORS

a) The participants know what is fertilizer

b) They also know importance of fertilizer use in crop production

STEPS FOR TRAINING

Total duration for this page: **15 Mins**

1) Ask participants why they use fertilizers?

2) Ask to mention a few advantaged of fertilizers (in comparison to other sources of plant nutrients)

Ask questions

Q1. What is difference between fertilizers and other sources of plant nutrients?
A1. Fertilizers are made in factory and contend more than 5% of N, P and/or K

Q2. What are the advantages of using fertilizers?
A2. They are fast acting with precise contents, easy to use and cheaper to buy

NOTES

IDENTIFICATION OF FERTILIZERS AND THEIR GRADES

BACKGROUND READING

Fertilizer Grades

1. Different fertilizers have specified nutrients in specified percentage of nitrogen, phosphorus or potassium and these percentages are expressed in fertilizer 'grades'.
2. The grade is an expression referring to the legal guarantee of the available plant nutrients expressed as percentage by weight in a fertilizer, e.g. a 20:20:15 NPK grade of complex fertilizer indicates the percentage of 20% nitrogen (N), 20% phosphorous (P_2O_5) and 15% potassium (K_2O).
3. The fertilizer grades are always expressed in the sequence of nitrogen, phosphorous and potassium, and prominently printed on the fertilizer bags, as in case of DAP the grade is 18:46:0 (NPK) and it is 0:0:60 for MOP.

Types of fertilizer

The amount and types of fertilizer use depends on soil fertility status, nutrient requirement of the crops, availability and losses of nutrients from the soils, previous crop grown etc.

Based on their use fertilizers are divided into two types:

1. Planting fertilizers:

- They are applied during planting time, also called basal or starter fertilizers. Generally, DAP, MOP, SSP, TSP and other blends are used as planting fertilizers.
- Nutrients required for early plant growth and not easily lost from the soils are applied during planting, particularly all nutrients except N.

Diammonium Phosphate (DAP):

- Compound fertilizer with nutrient grade 18-46-0.
- Contains 18% N and 46% P_2O_5 and 0% K_2O.
- Generally, it is applied during planting time as planting fertilizer or basal dose.
- Its current market price ranges Rs.45 to 50/kg.

OBJECTIVES

To increase the knowledge and awareness of attendees to the different types of mineral fertilizers (DAP, MOP, Urea and vermi compost)

LEARNING INDICATORS

The participants can:

a) Tell difference between planting and topdressing fertilizers

b) Identify DAP, MOP and Urea

c) Correctly read and understand the grades of the fertilizers on the fertilizer bags

d) Identify composition of fertilizers according to grade

TRAINING MATERIALS

a) Bags (empty) of DAP, MOP, Urea and vermi-compost

b) 100 gram samples of each DAP, MOP, urea and TSP

Start with;

1) Without fertilizer use crop production can be reduced by half or more

2) Proper use of fertilizer increases production, reduces cost of production, and improves soil fertility

DISCUSSION:

Invite questions for further clarity and discussion

Ask questions to assess learning level of the participants

Q1. Identify fertilizer grades of urea, DAP and MOP? (*Show fertilizer bags to participants*)
A1. 46:0:0; 18:46:0; and 0:0:60 in sequence for urea, DAP and MOP, respectively

Q4. What is the difference between 'planting' and top-dress' fertilizers?
A4. Planting fertilizers (DAP, MOP) are applied during final land preparation or planting time, while top-dress fertilizers (urea) applied when there is standing crops in the field!

Muriate of Potash (MOP):

- Straight fertilizer with nutrient grade 0-0-60.
- Contains 0% N and 0% P2O5 and 60% K2O.
- Generally, it is applied during planting time as basal dose.
- Its current market price ranges Rs. 33 to 35/kg.

Triple Superphosphate (TSP):

- Straight fertilizer with nutrient grade 0-48-0.
- Contains 0% N and 48% P2O5 and 0% K2O.
- Generally, it is applied during planting time as basal dose.
- TSP is not imported by fertilizer subsidy program of GON
- Its current market price ranges Rs. 85 to 90/kg.

2. Top-dressing fertilizers: It is applied at different growth stages of the crop.

- Generally, N fertilizers (urea, ammonium sulphate) are applied as top dress, because they are very prone to losses and cannot be retained in the soil for long time.
- It should be applied in multiple splits to meet plant demand and minimize losses due to volatilization, leaching and runoff. Topdress fertilizer can also be applied as foliar spray as well.

Urea:

- Straight fertilizer with nutrient grade 46-0-0.
- Contains 46% N and 0% P2O5 and 0% K2O.
- It can be used for both planting as well as top dressing fertilizer.
- Its current market price ranges Rs. 16 to 20/kg.

Ammonium Sulphate (AS)

- Straight fertilizer with nutrient grade 21-0-0, and also contain **24**% sulphur.
- Contains 21% N and 0% P2O5 and 0% K2O.
- It can be used for both planting as well as top dressing fertilizer.
- Ammonium sulphate is not imported by fertilizer subsidy program of GON
- Its current market price ranges Rs. 35 to 40/kg.

NOTES

ORGANIC MANURES AS COMPONENT OF ISFM

BACKGROUND READING

1. **Organic manures** are substances that are derived from the remains or byproducts of natural organisms (plants and animals) for example compost, green manures, plant residues, bio-fertilizers and other bulky organic matter which contain the essential nutrients for plant growth.
2. Organic matter improves physical, chemical and biological properties of soil.

In addition to providing plant nutrients, it has multiple benefits to improve the soil fertility

Advantages

1. Increase soil organic matter and improve soil health.
2. Improve soil physical, chemical and biological properties of soils.
3. Improve soil structure, water holding capacity of the soil.
4. Provides food for soil microorganisms and helps convert unavailable plant nutrients into available forms
5. Supply almost all essential plant nutrients consistently throughout the crop growing period if applied in great enough quantity.

However, there are some limitation of using organic materials as follows

1. Nutrient content is very low and require very high amount to meet nutrient demand of the crop.
2. Increase production cost due to higher transportation and handling cost thus expensive per unit
3. Farmers can use only locally available organic inputs *(difficult to buy in the market, as production and availability is limited)*

Therefore, organic manures which is available in local condition should be applied.

OBJECTIVES

To make participants aware of role of OM in soil fertility

LEARNING INDICATORS

a) The participants know sources of OM

b) They also know advantages of OM

STEPS FOR TRAINING

Total duration for this page: **15 Mins**

1) Ask participants why do they use OM in their crop field?

2) Also ask, what are the advantages of using OM in agriculture?

DISCUSSION:

Invite questions for further clarity and discussion

Ask questions to assess learning level of the participants

Q1: How OM contributes to soil fertility?
A1: Increases crop response to mineral fertilizers, more moisture storage, supports root growth, adds nutrients to soil and improves overall health of soil

Q3: How does improved seed benefit ISFM practices??
A3: Better suitable to farm conditions, more responsive to inputs, resistant to diseases and pests, and better in quality and market price

SOIL HEALTH: PH CHART OF NUTRIENT AVAILABILITY

BACKGROUND READING

1. The soil pH is a measure of the acidic or alkaline range of soils.
2. It is an important indicator of soil health.
3. Soil pH affects crop yields, crop suitability, plant nutrient availability, and soil microorganism activity which influence key soil processes.
4. Its range is 1 to 14. Typical soil pH falls between 3 and 10.
5. A pH 7 is neutral, pH below 7 is acidic and above 7 is alkaline.
6. Highly acidic soils (pH<3.5) and very strongly alkaline soils (pH>9) are rare but can occur in some cases.
7. Soil pH affects plant nutrient availability by controlling the chemical forms of the different nutrients and influencing the chemical reactions that govern the ability to plant roots.
8. The optimum pH range for most plants is between 6.0 and 7.5 *(However, some crop plants have adapted to thrive at pH values outside this range)*

If soil is acidic or alkaline, soil should be corrected as follows:

Amendments for acidic soils

1. When a soil is too acidic, for optimum soil pH, lime is added to the soil.
2. A lime is any material that contains calcium and/or magnesium which neutralize soil acidity.
3. The term agricultural lime includes many substances. Examples include **calcium carbonate, calcium hydroxide (hydrated lime), calcium- magnesium carbonate (dolomite-lime), and calcium oxide (burned lime)**.
4. Liming material also supply calcium and magnesium which are deficient in acid soils.
5. Effectiveness of liming depends on fineness of the material and timing of application.
6. Liming material should be applied 4-8 weeks before planting the crops. It should be applied uniformly and mixed thoroughly into the soils.

OBJECTIVES

To induce basic concept of soil health and suitable pH range of major crops

LEARNING INDICATORS

a) Participants know suitable pH range of major crop

b) They also know high acid or alkaline soils are bad for crop production

STEPS FOR TRAINING

Total duration for this page: **15 Mins**

1) Ask participants do they know what is soil pH?

2) Also ask, what will happen if soil pH range is highly acidic or alkaline?

Ask questions to assess learning level of the participants

Q1. What is optimal soil pH range for most of the crops?
A1. The optimum pH range for most plants is between 6.0 and 7.5, as most nutrients become available in this pH range.

Q2. What will happen if soil pH range is very high or very low?
A2. It will negatively affect crop yields, plant nutrient availability, and soil microorganism activity which influence key soil processes.

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BACKGROUND READING

Calcium Carbonate (CaCO3):

1. It is commonly used liming material, easily available, less expensive and effective in neutralizing acidity.
2. It is a ground limestone and also called as calcite.
3. Acid neutralizing value (or calcium carbonate equivalent) of other liming materials are calculated considering calcium carbonate as 100%.
4. Calcium hydroxide (Ca $(OH)_2$: It is prepared by hydrating calcium oxide and difficult to handle. However, it neutralizes soils rapidly compared to calcium carbonate. It has a neutralizing value of 136%, compared with pure calcium carbonate.

Calcium-magnesium carbonate CaMg $(CO3)_2$:

1. It is also called as dolomite.
2. The pure dolomite has a neutralizing value of 109%.
3. Both calcitic and dolomite lime are equally effective in raising soil pH.
4. However, unlike calcitic lime, dolomite lime also contains large amounts of magnesium.
5. Magnesium is an essential plant nutrient and mineral for healthy soil.

Calcium oxide (CaO):

1. It is most effective among all liming materials
2. Its neutralizing value of 179%, compared with pure calcium carbonate.
3. Selection of liming material depends on its availability, quality (purity and fineness) and cost

In addition to lime, organic matter also helps to neutralize soils.

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BACKGROUND READING

Amendments for alkaline soils

1. Soils having pH more than 7 are called saline or alkaline soils
2. Alkaline soils are common in the areas where water (rainfall or irrigation) is not sufficient to leach base cations from soils.
3. Soil pH of alkaline soil can be neutralized by different ways including use of chemical amendments, such as elemental sulphur (S), acidifying fertilizers (ammonium sulfate, urea ammonium nitrate), organic manure and leaching of soluble salts by irrigation.
4. Most of the fertilizers used in Nepal are acidic in nature, thus contribute to decrease salinity and alkalinity when applied in problematic (alkaline) soil.
5. Correcting soil salinity by chemical fertilizers (particularly ammonium containing nitrogenous fertilizers) may take several cropping-seasons.
6. Therefore, for immediate correction, farmers should use elemental sulphur.
7. However, the most relevant and practical ways of managing alkaline soils are leaching of soluble salts by salt free irrigation water and use of organic manures.

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LOCAL ADAPTATION OF ISFM

BACKGROUND READING

ISFM is not a 'silver bullet' but a 'best-fit' series of practices tailored to local conditions.

Farmers must consider their production objectives, land type, climatic conditions, importance, available production resources including land, labor, money, organic inputs etc.

Farmer must choose GAP for using their agricultural resources efficiently for better yields

1. Soil responsiveness

- **Responsive soil near settlement:** Some soils near the house respond well to fertilizers and are highly fertile
- **Responsive soil away from settlement: Some** soils in other parts of the farm are responsive to fertilizers
- **Poor responsive soil:** Some areas of the farm do not respond well to fertilizers. When you add fertilizers to these areas the plant do not grow bigger or give better yields
- Choose best investment option *(in this case fertilizer)*

2. Optimal plant population

- Plant the crop at right density, such as in case of maize, row to row 75 cm and plant to plant 25cm gives plant population of +/_ 1700 to 1800 per Kattha
- Smaller plant population is wasted of space and other inputs – less yield
- High plant population is per plan poor availability of space, nutrients and other resources – less yield
- Use crop varieties which have better efficiency to input use *(Harvest index)*

3. Efficient use of nutrients (4Rs)

- Right source
- Right rate
- Right time and
- Right placement

OBJECTIVES

To make participants aware of how ISFM is adapted with GAP in local conditions

LEARNING INDICATORS

a) Participants know suitable pH range of major crop

b) They also know high acid or alkaline soils are bad for crop production

STEPS FOR TRAINING

Total duration for this page: **15 Mins**

1) Ask the participants, what are factors to consider for more yield?

2) Also ask, can they suggest how to increase nutrient efficiency (fertilizer)?

3) Do they practice different cropping method to increase overall yield?

CONCLUDE THE STORY:

In case of mix cropping Khumane got production of 12 *kattha,* when compared with mono crops of wheat and lentil.

Invite question for further clarity

Ask questions to assess learning level of the participants

Q1: What do you mean by responsive soils?
A1: There are different types of soils. The soil which one gives better yield than other soils for the same amount of fertilizer is more responsive soil than the others.

Q2: What are some of the important GAPs?
A2: Maintaining optimal plant population, efficient use of nutrients (4Rs), choosing variety with high harvest index, choosing more productive cropping methods and making best use of other production input and methods.

Q3: What are some of the benefits of intercropping?
A3: More benefits to farmers by better use of space, light and soil nutrients, i.e. inter cropping

4. Optimizing agronomic efficiencies (AE):

Agronomic efficiency means how much additional yield you get per kg of nutrient applied from fertilizer or organic materials. *Increase in grain yield with application of same quantity of fertilizer (say, nitrogen in maize)*

In one kattha of land production of maize

a. without fertilizer it is 80 kg

b. with 5 kg urea it is 120 kg (8 kg for per kg urea)

c. with 10 kg urea it is 155 kg (7 kg per for per kg urea in case of second addition -5 kg)

5. Importance of intercropping: Intercropping is a multiple cropping practice involving growing two or more crops in proximity. The most common goal of intercropping is to produce a greater yield on a given piece of land by making use of resources or ecological processes that would otherwise not be utilized by a single crop.

Advantage of intercropping

- Intercropping gives additional yield income/unit area than sole cropping.
- It acts as an insurance against failure of crops in abnormal year.
- Inter-crops maintain the soil fertility as the nutrient uptake is made from both layers of soil.
- Reduction in soil runoff and controls weeds.
- Intercrops provide shade and support to the other crop.
- Inter cropping system utilizes resources efficiently and their productivity is increased

Importance with an example

a. Wheat in 5 *kattha* and produced 500 kg grain = 100 kg/*kattha*

b. Lentil in 5*attha* and produced 150 kg grain = 30 kg/*kattha*

c. A mix crop of wheat and lentil in 10 *kattha* and produced 800 kg wheat and 120 kg lentil (compare it with the above two yields):

- 800 kg wheat/100 kg per *kattha* = 8 kattha
- 120 kg lentil/30 kg per *kattha* = 4 *kattha*

Equivalent to 12 kattha crop

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