

Training Curriculum

For the purpose of the Project

“Natural Resource Management and Promotion of Sustainable Farmers’ Livelihoods in Four Districts of Samangan”

Soil Fertility

Topics Covered:

Assessment of Soil Fertility

Nutrient Cycles

Application of Chemical Fertilizers

Preparation and Application of Compost

Green Manure Crops

Training Duration: 2 Days

Prepared by: Matouš Bořkovec and Mohammad Yousuf Fakur People in Need, 2016

GENERAL LEARNING OBJECTIVE

By the end of the training the participants will be familiar with the topic of soil fertility and the ways of its assessment and improvement in order for them to be able to improve it by chemical fertilizers, composting and green manure.

Specific learning objectives – knowledge

By the end of the training, participants will know:

- Three components of soil texture (clay, silt, sand).
- Signs of good and bad conditions of soil (its texture, structure, colour, earthworms).
- How nutrients (especially nitrogen) cycle in their agricultural production and how nitrogen is lost.
- Content of urea and DAP fertilizers, their correct dosing and timing of application with wheat.
- Why organic matter content is important in soil and how it can be increased.
- Reasons for composting and obstacles to composting.
- Open and closed composting methods.
- Correct composition of compost (nitrogen and carbon content of organic materials).
- Why urea can be added to compost and how.
- How and when compost should be applied to soil.
- Why and how to cultivate green manure crops.
- Fixation of nitrogen by legumes.

Specific learning objectives – skills

By the end of the training, participants will be able to:

- Assess texture of soil by feel.
- Assess structure of soil by spade test.
- Assess aeration and organic matter content visually.
- Assess condition of soil by earthworms.
- Apply urea and DAP to wheat in correct time and doses.
- Use urea in solid form as well as dissolved in water.
- Build a quality composter (open and closed).
- Care for compost and recognize when it is ready.
- Apply compost to the soil at the correct time and dose.
- Cultivate green manure crops in a sustainable way and incorporate them into the soil to increase soil fertility.
- Identify if their legumes fix nitrogen or not.

TRAINING DURATION:

The training is designed for 2 days.

TRAINING LOCATION:

Suggested location for the training is: Rain-fed demo plot and irrigated demo plot with composters.

NECESSARY TOOLS AND MATERIAL:

- Spade (preferably European style with big strong plate)
- Chemical fertilizers (urea, DAP), water for dissolving urea, sprinkler
- Signboards, markers to write on the signboards
- Open composter (wooden with removable roof), hole for closed composter
- Organic materials (animal manure, straw, crop residues, etc.) for composting
- Seeds of green manure crops
- A plot of already grown green manure crops (different species with different techniques)
- A plough with donkeys/oxen – locally used equipment

TRAINING SCHEDULE

Day 1

Activity	Name	Duration
Introductory Activity	Discussion: Factors Affecting Growth of Crops	15 minutes
Training Activity 1	Visual assessment of soil	1 hour
Training Activity 2	Discussion: Nutrient Cycles	20 minutes
Training Activity 3	Application of Chemical Fertilizers	1 hour
Training Activity 4	Discussion: Importance of composting	15 minutes
Training Activity 5	Composting – open and closed composter	1.5 hours
Final Activity	Questions checking learning progress	20 minutes
Total time		4 hours 40 minutes

Day 2

Activity	Name	Duration
Introductory Activity	Discussion: Review of Day 1 topics	20 minutes
Training Activity 1	Discussion: The concept of green manure	20 minutes
Training Activity 2	Observing nodules in leguminous crops	30 minutes
Training Activity 3	Discussion: Time-plan for green manure crops	20 minutes
Training Activity 4	Incorporation of green manure crops into soil	1 hour
Final Activity	Questions checking learning progress	20 minutes
Total time		3 hours 10 minutes

DAY 1

INTRODUCTORY ACTIVITY - DISCUSSION: FACTORS AFFECTING GROWTH OF CROPS

Ask the participants: What affects growth of your crops? In the discussion, they will probably mention some or all of these factors:

- Quality of seed
- Weather (rainfall)
- Quality of soil
- Weeds, pests and diseases
- Timing of sowing (Crop calendar)

You can ask them; which of the factors they think are most important for the resulting harvest. Maybe they will not be able to agree. In fact, **all of the factors are very important for the resulting harvest.** After you agree on this you can explain to them that this training is going to focus on one of these important factors and that is **QUALITY OF SOIL and ITS FERTILITY**. This factor is often overlooked but can be influenced by the farmer and thus it can greatly affect the yield. Soil fertility is a long-term process.

TRAINING ACTIVITY 1: VISUAL ASSESSMENT OF SOIL

Explain to participants that we can assess the fertility of soil (to some degree) by simple observations. Maybe they already use some of these techniques. Ask them: **What are you looking for in the soil when you want to assess its fertility?**

Maybe they will tell you: *"We decide by colour. If the soil is darker, it is better. Light colour of soil is bad."* That is, in general, a great observation. Another answer might be *"We look at the structure of soil. If it has a lot of stones or if there is a lot of dust (the smallest particles or clay) we know that the quality is not good."* This is also a good observation. **You should appreciate very much all such observations. Before you start explaining anything to the farmers, allow at least one of them to show exactly to the others how he assesses the quality of soil.** When that is done, tell them that now you will show a few techniques of how it can be done.

Right conditions for visual soil assessment

Prepare a small piece of land on the demo plot for the visual soil assessment. **Very important: The soil must have correct moisture!!** That means, it should not be too wet but also not too dry. It should be moist but water should not be standing on the soil or the soil should not be completely saturated by water. You should feel it is wet but the soil should not be "muddy". If you are not sure, apply the 'worm test'. Roll a worm of soil on the palm of one hand with the fingers of the other until it is 5 cm long and 0.5 cm thick. If the soil cracks before the worm is made, or if you cannot form a worm (for example, if

the soil is sandy), the soil is suitable for testing. If you can make the worm, the soil is too wet to test.

Visual soil assessment step by step

Show each of the steps to the training participants. Let them try the process themselves, discuss the reasons with them.

1. Taking a sample of soil

- Dig a small hole about 20x20 cm and 30 cm deep with a spade.
- Dig out a 20x20x20 cm cube with the spade from one side of the hole. You can choose to assess the top soil or some lower parts of soil. In any case, dig a cube of 20x20x20 cm with the spade and take it out of the hole.
- Drop the test sample a maximum of three times from a height of 1 m into a plastic basin or onto a plastic or wooden board. If the soil shatters into small pieces after the first drop, do not drop it again. If it only splits into few big pieces, drop the big pieces again. Drop each piece a maximum of three times.



Dropping the soil from a spade onto a plastic board (spade shatter test).

2. Assessment of soil texture by feel (Making a ball)

Soil texture is defined by the size of mineral particles in the soil. **The smallest particles are clay, middle sized are silt and the biggest are sand.** In general, the middle-sized particles (silt) are best for plant growth, but there can be many different ratios of these components that are fine.

Take a small sample of soil (half the size of your thumb) from the topsoil and a sample of the subsoil. Put the samples together – now you have one sample containing both topsoil and subsoil. Wet the soil with water, kneading and working it thoroughly on the palm of your hand with your thumb and forefinger to the point of maximum stickiness. Try to form the soil into a ball. If you manage to form the ball, try to press into a flat shape so that you can feel the soil texture.



Making a ball from soil and pressing the ball to feel its texture.

Then assess the structure of the sample soil by comparing it to the conditions in the table below:

Quality	Structure	Condition
Good	Silt loam	Smooth soapy feel, slightly sticky, no grittiness. Molds into a cohesive ball that fissures when pressed flat.
Moderately good	Clay loam	Very smooth, somewhat sticky and plastic. Molds into a cohesive ball that deforms without fissuring when pressed flat.
Moderate	Sandy loam	Slightly gritty, faint rasping sound. Molds into a cohesive ball that fissures when pressed flat.
Moderately poor	Loamy sand	Loamy sand: Gritty and rasping sound. Will almost mold into a ball but disintegrates when pressed flat.
	Silty clay, Clay	Silty clay, clay: Very smooth, very sticky, very plastic. Molds into a cohesive ball that deforms without fissuring.
Poor	Sand	Gritty and rasping sound. Cannot be molded into a ball.

Source: *Visual Soil Assessment Guide*, FAO, 2008

Bigger particles like gravel or stones can, of course, be also present in the soil, generally making plant growth more difficult. If they are present in such amounts that they cannot be removed from the field before crops are cultivated, the soil quality should be assessed as one level lower (for example from moderately good to moderate).

Now that you know the **texture** of soil, you can assess its **structure**.

3. Assessing structure of soil

After you dropped the soil into the plastic basin (as described in step 1), transfer the soil onto a large plastic bag so that you can organize it in a similar manner to the picture below. After you put the big pieces to one side and smaller pieces to the other, compare the result to the picture.



Source: *Visual Soil Assessment Guide*, FAO, 2008

Note: Avoid doing the test in very dry or very wet conditions!

4. Assessing the organic matter content

The amount of organic matter content is one of the most important indicators of soil fertility. For our purposes it will be enough to assess the amount of organic matter content by colour, smell and organic residues. In general, the darker the colour is, the greater is the amount of organic matter in the soil. However, it is best to **compare the colour of our sample to a sample of soil from the same area from protected conditions**. Protected conditions mean that the soil was not cultivated during past years and was permanently covered by vegetation (enclosed areas where grazing doesn't take place, soil from under a fence etc.). Compare your sample to the pictures below as well as to the sample from the protected area.



Source: *Visual Soil Assessment Guide*, FAO, 2008

In general, the darker the colour of the soil, the more organic content it has. Darker soil (left) has better fertility than lighter soil (middle) and light soil (right).

The soil should not have any coloured spots – these are chemical components formed under conditions of bad aeration or bad drainage. Compare your sample to the pictures below:



Source: *Visual Soil Assessment Guide*, FAO, 2008

Soil without any coloured spots (on the left) signifies good aeration and drainage. Coloured spots (centre

and right) mean aeration or drainage are not good – soil probably lacks organic content.

Smell the soil. Use your nose. Soils with adequate organic matter content will have the rich smell of earth. Soils that have poor air circulation, a result of reduced organic matter content, may smell sour or stinky. Compare the smell of your soil to the smell of good-quality compost. Do you smell a little bit of that earthy compost smell from your sample of soil as well? If yes, you smell the organic content.

Look for organic residues (small parts of plants and roots). If they are present, they indicate that the soil has some organic content.

5. Counting the earthworms

EARTHWORMS provide a good indicator of the biological health and condition of the soil. Through their burrowing, feeding, digestion and castings, earthworms have a major effect on the fertility of soil. They shred and decompose plant residues, converting them to organic matter, and they mix the soil, improving its aeration and drainage. In general, the more earthworms live in the soil, the better.



Use the sample of soil taken for analysis of its structure. Break all the bigger parts of the soil and count the earthworms that you find. If you find more than 20 of them (preferably of more species), the soil has a very good quality. If they are less than 5, the quality is not good. But the exact amount depends on local conditions – you can compare the numbers in samples from different sites. In general, more earthworms mean better quality of soil.

Result of the activity

After all the participants understand each soil assessment technique, discuss what is the result of your experiment with the sample. Is your soil good or bad quality? Does it have enough organic matter content? In general, adding organic matter (compost, composted manure or crop residues) can improve any soil.

TRAINING ACTIVITY 2 - DISCUSSION: NUTRIENT CYCLES

This activity is rather theoretical, so it is best to sit down in a suitable place with the participants (shade, inside a room etc.).

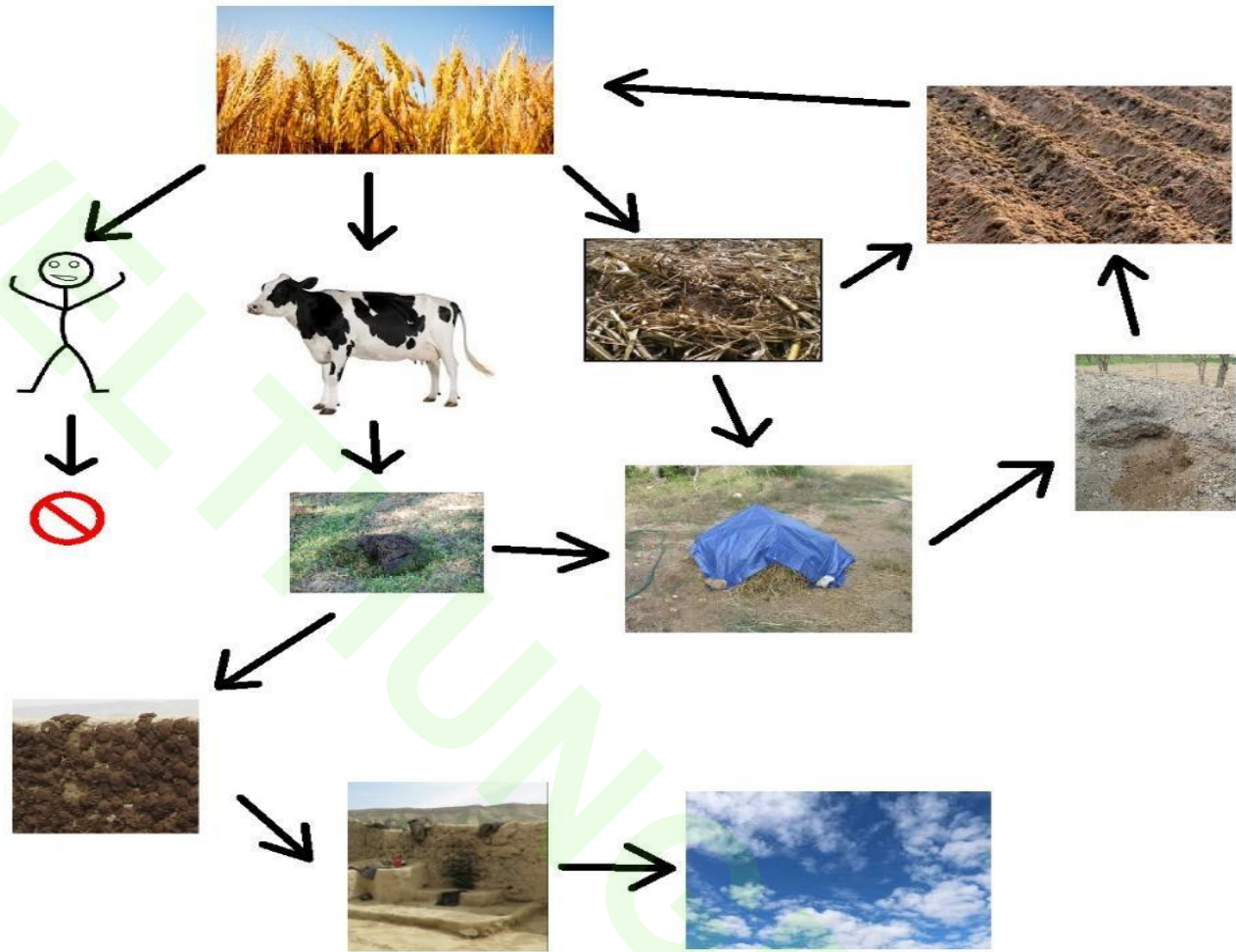
The participants should understand that plants are composed from carbon, which they take from air thanks to sunlight and water, and also from other nutrients (especially nitrogen, phosphorus and potassium) and that these nutrients are taken from the soil. Nitrogen is one of the most important nutrients. It is the one that is most often missing in Afghan soils.

Nitrogen is present in the air but plants are not able to take it from the air. Therefore, they need to take it from the soil. When they take it from the soil, they use it to build plant tissue. The green parts of plants contain more nitrogen than the yellow or brown parts. **A key question is: What happens to the nitrogen (and other nutrients) when a plant dies?** A lot of the nitrogen can be used to make other plants grow again! Or all of it can be lost – it can go into the air. Have a look at the picture below. It is a scheme of nitrogen cycle relevant to Afghan farming.

Use this picture to show to the farmers how important it is to put nitrogen back on the field – in the form of crop residues, manure, composted manure or compost.

Explain it to them somewhat like this: “Wheat (and all the other crops) take nitrogen (and all the other nutrients) from the soil as they grow. When we harvest wheat and make bread and eat the bread, the nitrogen is present in our excrement. But, to protect health and hygiene we do not use those for fertilization of fields. We could become sick if we did that. We give the straw or the grain to animals to eat. Now the nitrogen is present in the excrements of animals – in the manure. We have a choice what we do with the manure. Some people need to use it to heat their houses and to bake bread – so they use the manure to make tapak and they burn it in the stove or tandoor. In this way all of the nitrogen goes into the air! Plants cannot take it from the air. Or we can put the manure onto a compost pile, or directly onto a field. Then we put the composted manure onto the field. Nitrogen is now in the soil in the field and the crops can use it to build their bodies again!”

It is clear that the farmers often do not have the choice and they need to use the manure for heating or cooking. Yet, you can tell them that they should try to save as much manure as possible for the field as this will help to have higher yields.



Nitrogen cycle relevant to farmers in Afghanistan

Make sure that everyone understands what nitrogen is, how the plants use it and how it is being either released to atmosphere or put back into the soil. Tell them that there are three basic ways how the nitrogen (and other nutrients) can be supplied into the soil: Chemical fertilizers, animal manure or compost and green manure. The rest of the training will be about the first two ways of fertilizing of the soil (chemical fertilizers and composting).

TRAINING ACTIVITY 3: APPLICATION OF CHEMICAL FERTILIZERS

The use of mineral fertilizers is one of the most obvious ways how to add nitrogen (and phosphorus) into the soil and how to increase yield. However, their usage - to be efficient as well as cost effective - requires careful timing, dosing and right application technique.

Moreover, their effect in rain-fed conditions is hindered by lack of the moisture necessary to dissolve them and make the nutrients available to the plants. Excessive water (in high intensity rains) can also wash them out without any effect! The efficiency of fertilizers in rain-fed conditions needs to be further studied by project staff in the rain-fed demo plots! Over-dosing or improper timing can cause more harm than good, especially in rain-fed conditions. Also, the relatively high cost of chemical fertilizers can be a big obstacle. Their cost can outweigh their benefit. However, if they are used carefully, they can be very useful!

Two most widely available fertilizers in Samangan are urea and DAP (diammonium phosphate). Urea is solely a source of nitrogen (it contains 46% of nitrogen). DAP is a source of phosphorus (46% of phosphorus) and smaller amount of nitrogen (18% of nitrogen).

Next to nitrogen and phosphorus, another important nutrient is **potassium (K)**. However, potassium is generally not deficient in Afghan soils and is not necessary to add. Its source is for example ash from biomass (wood, shrubs, grasses). Ash from biomass generally contains nutrients in the ratio of 0:1:3 (0% of nitrogen, 25% of phosphorus and 75% of potassium). But, the risk of using too much ash is that the pH of the soil will be increased to even more alkaline! The pH of ash is 12!

Phosphorus (P) is not as volatile in the soil as nitrogen, therefore it is enough to add it to the soil once per year, usually before sowing, in order to supply enough phosphorus for the upcoming growing season. It's main source in Afghanistan is DAP or animal manure. Some phosphorus is also present in ash from biomass (but remember risk of using ash).

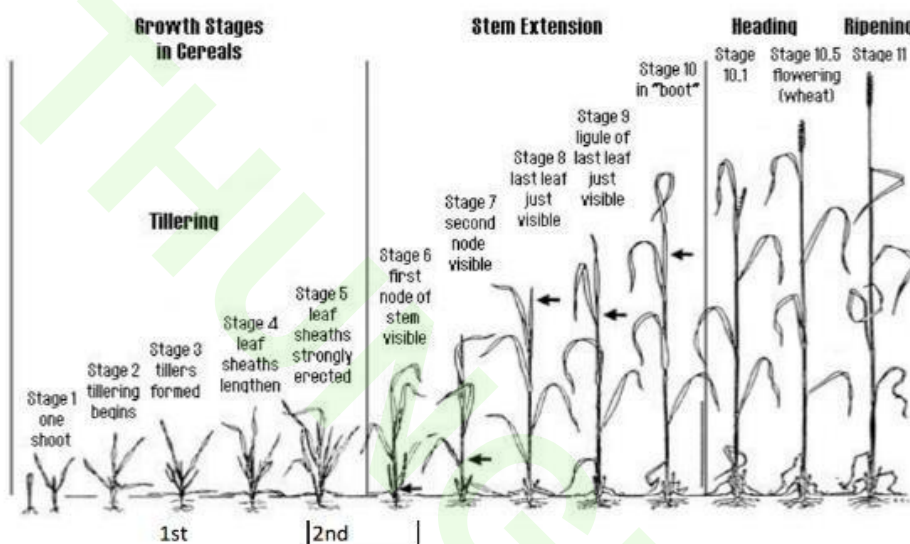
Nitrogen is more volatile in the soil than phosphorus, that means it is easily lost into atmosphere or washed away by water! Therefore, its application must be very well dosed and timed. If applied before sowing, there is a risk of its leaching out of the soil, or if it is in contact with the seed of winter wheat, it could cause the seed to be more susceptible to frost. The application before seeding causes the wheat to form more tillers (off-shoots). It depends on the kind of seed; local varieties can form around 4 tillers, while improved varieties up to 10! In the condition of rain-fed cultivation, formation of more tillers is not desirable, as it increases the needs of the plant for water. However, the lalmi varieties of wheat might have special characteristics in this regard, so appropriate usage of fertilizer with lalmi varieties should be further consulted with the seed companies as well as farmers themselves, and tested in demo plots!

Appropriate timing, dosing and ways of application of fertilizers with wheat

The dosing of fertilizers depends on the amount of seed that farmers use per jerib (seeding rate). The following information is based on seeding rate of 2-4 sers per jerib (or 80-140 kg per hectare). Ask the farmers which seeding rate they use! They might be using a different seeding rate for rain-fed and for irrigated land. They might be also using a different rate for different varieties!

It is also very important to know the stages of growth of winter wheat as the timing of application depends on them, as well. Look at the following picture:

FECKES GROWTH STAGES IN WINTER WHEAT



Source: afghanag.ucdavis.edu

Discuss the growth stages of wheat with the farmers. Focus especially on stage 3 (formation of tillers), stage 6 (stem has a first node visible), stage 10 (flowering stage) and 11 (formation of grain and ripening).

Application of fertilizer before or at plantation (October or November)

Fertilizer should be applied into the soil ideally around 4 cm below the seeds. This can be done either by appropriate sowing machines or by hand (broadcasting) if no machines are available. Application of DAP is recommended before plantation as phosphorus needs to be applied deeper into the soil close to the future roots of the plants, as its mobility in soil is limited.

The maximum recommended dosing is 38 kg/jerib of DAP. Urea can be applied instead of DAP, but this does not refill the phosphorus in the soil. If urea is applied, the maximum recommended dose is 15 kg/jerib. The fertilizer should not be applied too close to the seed as it can have negative effects on germination, also could lead to more damage of plants by frost during the upcoming winter.

Before plantation, the application of composted animal manure is also very beneficial for long-term health of the soil. The fertilization before plantation should not be overdosed! If all the fertilizer for the season is applied at planting (or the dose is simply too high) and if precipitation turns out to be below

average, the crop has been over fertilized, and it uses up all available water and dries out.

Spring fertilization (March to May)

If the wheat is very sparse after the winter and has not created many tillers, more spring wheat seed can be added and more fertilizer can be applied in growth stage 3 (see the picture above) to support the establishment of healthy tillers. This would take place approximately at the beginning of March. The maximum recommended dose is 30 kg of urea per jerib.

However, in rain-fed conditions too many tillers can cause the plant to dry! So this is more relevant to irrigated conditions.

Second application of fertilizer in spring can be done in growth stage 5 – 6 (creation of node on the stem). This dose must be limited as otherwise too much vegetative growth would be supported. The maximum recommended dose is 10 kg of urea per jerib.

In case the weather is suitable (there is enough moisture in the soil to absorb urea), the fertilizer can be applied also during the flowering and grain formation stages (stage 10) in order to have more and bigger grain. This stage would come in late May or early June. The applied amount should be limited, maximum 10 kg of urea per jerib.

Application of urea dissolved in water “on leaf”

The last mentioned “late fertilization” can be also done by applying the water solution of urea directly on the leaves of the plants. The concentration of urea in water needs to be only 2-5 % (2-5 kg/100 litres), not more, otherwise the fertilizer can cause burns and damage the crops. This kind of fertilization must be done in suitable conditions, this means not in too hot weather or under direct sunlight (evaporation of water causes the concentrations of urea to increase!), meaning it should be done in the evening or when the weather is cloudy and air humidity is higher.

However, in comparison with application into soil, the application of urea solution on the leaves can lead to the so called “green effect” (improving the look of the plants, making them more lively and green) but having little effect on yield. However, if combined with good conditions in the soil (for example application of animal manure before sowing) it can lead to longer maturing periods of grain and therefore higher yields (bigger grains with better contents). This is also recommended more for irrigated land rather than rain-fed.

Discuss all of the methods of application of fertilizers with the farmers and apply the fertilizers to the crops on the demo plot (if the training is conducted in suitable time!). Remember to record the exact amount, type of fertilizer and date of application on the signboard next to the demo plot! It is absolutely essential for the learning process as later you can compare the crops that were fertilized with those that you left without fertilizer.

All of the methods of application of fertilizer should be tested like this (together with the farmers) on the demo plot!

TRAINING ACTIVITY 4: DISCUSSION – IMPORTANCE OF COMPOSTING

It is essential for participants to understand why composting is so important. Ask them a question: **What is composting?** And if they are not able to answer, tell them that it is **the process of changing crop residues, animal manure or any organic material into a very fertile soil**. This change is performed by **bacteria**. Bacteria need water and the right temperature to operate.

Animal manure contains a lot of nitrogen. This is very valuable for the field! But the **nitrogen from animal manure slowly escapes to the air**! If you just put animal manure on the field, more than 50% of all the nitrogen will be lost to air! But, if you **compost the animal manure, the nitrogen is not lost into air** (see picture below).



We avoid loss of nitrogen by composting the animal manure! We need to mix the manure with straw or similar brown crop residues. We can also mix it with soil. Then we need to cover it with a plastic sheet and the result is composted manure. We avoided loss of valuable nitrogen!



One reason why to compost is to avoid nitrogen loss from animal manure.

When we leave crop residues on the field, it is good but we need to plough them into the soil in order for them to decompose and release nitrogen for new crops to use. The decomposition can be slow, especially if the weather is dry.

The second reason for composting is to make the decomposition process faster in order to prepare the fertilizer for the next crop.

Also, during the composting process, high temperatures are created. These help to kill the germs of pests and diseases as well as some weed seeds. So, thanks to composting we can keep our fields healthy. This is a third reason for composting.

Obstacles to composting

Ask farmers if they see any obstacles to composting. Farmers might tell you that they don't have any crop residues to put into compost as they feed all of them to their animals. Your answer should be, that it is ok because animal manure should be composted as well! So instead of putting the residues to the compost, they should put in the animal manure and add only a bit of residues, for example straw.

Another obstacle could be that the farmers do not have enough water to keep the compost wet. If this is the case, then they should definitely use the closed composting approach – under the ground – as with this approach the amount of required water is smaller.

Another obstacle could be that the farmers do not have time to work on compost – that it is too laborious to prepare it. This might be a tough obstacle as we have to admit that composting requires some labour. But, you should stress, that without composting all of the nitrogen from their crops is lost to the air. With composting it is put back in the soil and used by new crops. Therefore, their labour with the compost will pay back! They will have higher yields and their fields will not be so easily depleted thanks to compost.

TRAINING ACTIVITY 5: COMPOSTING – OPEN AND CLOSED COMPOSTERS

There are two basic ways to do composting in Afghanistan: Open and Closed. You should teach both ways to the farmers. Have both composting places ready at the demo plot before you start the training! You need a hole in the ground (at least around 1x1x1 m) for closed composting and you need a composter from wood or plastic (see below) for the open composting. Use a corner of two walls for the open composter to provide shadow!

Open composter

An open composter should be kept in a shaded and cold conditions (as Afghanistan is a very warm country in summer) in order to minimize loss of water and avoid overheating. For that reason, the heap should be kept in a shaded place (for example in a corner of two walls, under a roof) and it can also be half underground to keep it cooler. An example of such a composting place is shown in the picture below.



Open composter – in countries with mild climate the roof is not necessary, however in Afghanistan without roof the compost gets dry and the composting process is stopped.

The open composter should have a removable roof – in this way it will be kept cool even if under full sun. But at the same time, turning or mixing of the compost will be possible when the roof is removed. The roof can be a wooden board.

If no roof is available, a thick plastic sheet should be used to cover the heap (stones can be used to keep the plastic sheet in the position). A plastic sheet should only be used if we can keep the composter in shaded conditions. If direct sunlight shines onto the compost (and it is summer season), a plastic sheet is not suitable – temperatures would rise very high under the cover.

Too warm weather can lead to overheating (with increased loss of nitrogen as ammonia evaporates) and drying, slowing down the composting process. In Afghan conditions, the insulation of the compost heap should be thorough and its size bigger so that it can be successfully used even in adverse weather conditions.

The compost must be kept wet, otherwise the decomposition process will be stopped. It should also be turned from time to time in order to mix it properly and improve aeration. All the family members can be involved in keeping the compost moist and turning it from time to time.

Closed composter

Closed composting means that we put the material in a hole in the ground and cover it with soil, leaving it to decompose underground.



Hole for closed composting in Khwaja Sangbur, Samangan, and buried compost next to it.

After digging the hole, we simply put all of the organic material intended for composting into the hole, making layers with the manure and crop residues, then we press it with our feet and then cover with earth. We should also water the compost thoroughly before covering it with earth in order to ensure that the process of decomposition will begin. The closed composter should be watered from time to time to keep the content moist underground. If it becomes dry, the composting process will be stopped. Composting underground usually takes a longer time than open composting. In this way the process can take 3 – 5 months. You can uncover a little bit of the compost from time to time to assess its condition. A ready compost looks like a dark soil, has a pleasant earthy smell and original pieces of organic material are not well visible in it (or only some of them are).

Compost is ready to be used.



Composition of compost

In Afghan conditions, we should use all organic material we can find. For example, crop residues, straw, bushes, branches, grass, leaves, animal manure. Important: all the organic material must be cut into small pieces! If bigger pieces of wood or plants are put onto the compost, they will not decompose. It is important to reach balance between material containing a lot of nitrogen and material containing a lot

of carbon. If we have too much nitrogen, it will be wasted. If we have too much carbon, the composting process will not start. See table for nitrogen and carbon content of selected organic material:

High nitrogen content	High carbon content
Animal manure	Straw
Residues of vegetables	Sawdust
Green grass	Wood
Food waste	Bark
Hay	Paper
	Corn stalks
	Leaves

You should mix (or layer) the material with high nitrogen content together with material with high carbon content (for example animal manure with straw or leaves). In this way you will reach a good result!

Adding urea

In case that you have abundance of material with high carbon content (for example straw, leaves, branches) but you do not have enough material with high nitrogen content to mix it with (for example you do not have animal manure, grass, food waste or hay), you can add urea (artificial fertilizer containing nitrogen) into your compost. This will make the composting process very quick and efficient!

Use approximately 0.6 kg (600 g) of urea per 1 cubic meter of composted material. It is a good idea to dissolve urea in water first and then to spray it as evenly as possible on the composted material.

Usage of compost

It is necessary to observe your compost from time to time to see whether it is ready or not. If it had a lot of animal manure content, it might be ready already after 1 or 2 months! Other materials will take longer to process, especially if they were not cut into small pieces. Closed compost will take longer than open compost. In general, after 6 months it should be ready (if it was watered properly).

Compost should be mixed with topsoil in your field. Its impact will be most visible with vegetables, potatoes or generally in intensive agriculture. However, its application will always have a beneficial impact for soil fertility even in the conditions of rain-fed extensive agriculture. So you can apply compost also on your wheat field in the autumn, before sowing the seeds.

Results of activity

Make sure that you show practically to the participants all of the topics described in this activity. These activities are: open and closed composting (including preparation of the composter), selecting the right composition of your compost, watering compost, adding urea to your compost and discussing when the compost will be ready and how we can apply it. Make sure that all the participants understand all parts of this activity.

FINAL ACTIVITY: QUESTIONS CHECKING LEARNING PROGRESS

Ask each participant at least one question and let them answer, explain to others and show it practically, without any interference from the trainers' side. After the participant answers, allow others to add their ideas or opinions or correct the answer if necessary. Give an appropriate mark to the group response as indicated below. Calculate the total score after the training is finished and report it to your line-manager.

Q1: *What are the three components of soil texture? Which components are smallest, which are medium size and which are biggest and how can we practically identify the texture of the soil?*

Right answer: The three components are clay (smallest particles), silt (medium sized) and sand (biggest particles). We do not count gravel and stones – these are not considered as part of the soil and generally are not good for plant growth. The texture of soil can be assessed by feel, taking a sample of both topsoil and subsoil and attempting to make a ball (after adding water) and then pressing the ball and feeling the texture of the soil.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know, unable to show practically.	Know the components but are not able to show practically.	Know the components and are able to show practical test but with some mistakes.	Know the components and are able to show practical test without mistakes.

Q2: *Which signs in soil can tell us whether its condition is good or bad? Please practically show the spade shutter test and visual assessment of soil.*

Right answer: When we do the spade test, we can assess the structure of soil based on the amount of small or big clods of soil (see pictures above). We should also look at the color of the soil and compare it with the color of soil from a protected area (for example under a fence). The darker the color, the better the soil in general (more organic content). The soil should not have any colored spots (this signals weak aeration or weak drainage). We should also look for earthworms and count how many there are in one 20x20x20 cm cube of soil. If there are less than 15 of them, the soil quality is not good. If there are more than 30, it is good.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know, unable to show practically.	Know the spade test but cannot explain the visual assessment.	Know all the signs of soil conditions and can show it practically with some mistakes.	Know all the signs of soil conditions and can show it practically without mistakes.

Q3: Explain how nutrients, especially nitrogen, are lost into the atmosphere. When and how does it happen? How can the nutrients be put back into the soil?

Right answer: Nitrogen is lost into atmosphere when animal manure or crop residues (straw) are burned. Approximately 50% of nitrogen from animal manure is also lost into air if manure is not properly composted but just put on the field. Nutrients can be put back into the soil by composting crop residues, animal manure and other organic materials and putting the compost on the field.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know.	Can explain only one way of nitrogen loss.	Can explain the loss of nitrogen well but with some mistakes.	Can explain the loss of nitrogen well without mistakes.

Q4: What is the content of urea and DAP? How much DAP and urea would you use for one jerib of rain-fed and one jerib of irrigated wheat? When and how would you apply the fertilizers?

Right answer: urea contains only nitrogen, DAP contains mostly phosphorus and little bit of nitrogen. DAP should be applied before plantation, just once per year. Maximum dose is 38 kg of DAP per jerib. If urea is applied instead of DAP before plantation (in November or December), maximum dose is 15 kg per jerib. In irrigated conditions, urea can be also applied at the beginning of March and the maximum recommended dose is 30 kg of urea per jerib.

This will increase the formation of tillers (not desirable in general in rain-fed conditions). A second application of fertilizer in spring can be done in growth stage 5 – 6 (creation of node on the stem). This dose must be limited as otherwise vegetative growth would be supported too much. The maximum recommended dose is 10 kg of urea per jerib. In case the weather is suitable (there is enough moisture in the soil to absorb urea), the fertilizer can be applied also during the flowering and grain formation stages (stage 10) in order to have more and bigger grain. This stage would come in late May or early June. The applied amount should be limited, maximum 10 kg of urea per jerib. In rain-fed conditions the fertilization depends on weather conditions (moisture is necessary) and should be limited.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know.	Can explain the composition of fertilizers but not dosing and timing.	Can explain the composition, dosing and timing of fertilizers with some mistakes.	Can explain the composition, dosing and timing of fertilizers without mistakes.

Q5: What is the risk of putting ash from tandoor as a fertilizer on your field? Which nutrients does the ash contain?

Right answer: The ash contains no nitrogen, a little phosphorus and more potassium. As mostly nitrogen or phosphorus are missing from Afghan soils but not potassium, it is not necessary to add ash to the

field. It also has a risk of increasing the pH of soil too much, making it very alkaline. pH of ash is 12.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know.	Can explain the risk of using ash but not composition.	Can explain the composition of ash as well as its composition with some mistakes.	Can explain the composition of ash as well as its composition without mistakes.

Q6: Explain why it is good to do composting and which obstacles people are facing in Afghanistan with regards to composting?

Right answer: Composting animal manure can prevent loss of nitrogen into atmosphere. Composting can speed up the process of decomposition of crop residues which otherwise would take very long to decompose in the field. The process of composting creates high temperatures that kill germs of pests and diseases as well as seeds of weeds present in the compost. So composting, when done properly, increases the health of the fields.

Obstacles to composting are: Not enough crop residues as all are fed to animals (but animal manure is perfect for composting!), problems with dry weather (compost is drying up which stops the process – it must be watered – but closed composting needs only small amount of water). Last obstacle is that composting needs work – it is laborious. But, it can increase yields and keep soil productive so the labor pays off in the end!

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know.	Can explain only one reason or obstacle.	Can explain the reasons and obstacles but some are missing or incorrect.	Can explain all the reasons and obstacles well and in a correct way.

Q7: Explain and show practically the difference between an open and closed composter. How it looks and why.

Right answer: An open composter is usually an open wooden structure. It is best placed in a corner of two walls. It must be kept in a shadow otherwise it will be too hot and dry. It should have a removable roof if otherwise the sun would be shining directly on it. It can be half underground. It can be covered with a plastic sheet (if direct sun is avoided). It must be watered and turned / mixed regularly.

A closed composter is a hole in the ground where all the material is piled and pressed, mixed, watered and then covered with soil. Closed composting takes longer time than open composting but needs less water.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know.	Can explain only one way of composting.	Can explain both ways of composting but with some mistakes.	Can explain both ways of composting very well.

Q8: Which materials contain a lot of nitrogen and which materials contain a lot of carbon? Name at least 6 examples.

Right answer:

High nitrogen content	High carbon content
Animal manure	Straw
Residues of vegetables	Sawdust
Grass	Wood
Food waste	Bark
Hay	Paper
	Corn stalks
	Leaves

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know.	Only one or two correct answers.	Three or four correct answers.	Five or more correct answers.

Q9: Why and when would you add urea to compost? How much of it per cubic meter of compost?

Right answer: Urea is used when there is no other source of nitrogen (only material with high carbon content is available, like straw, leaves, sawdust, paper etc.). The recommended dosing of urea in this case is around 0.6 kg per 1 cubic meter of compost. It should be dissolved in water and sprayed on the compost.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know.	Knows why to add urea but doesn't know why and how.	Knows why and when to add urea and how much with some mistakes.	Knows why and when to add urea and how much without mistakes.

Total Points Received:

_____ OF 27 POINTS or _____%

DAY 2

INTRODUCTORY ACTIVITY - DISCUSSION: REVIEW OF DAY 1 TOPICS

Sit with the participants in a pleasant place (outside in the shade or inside a room). Ask the participants to tell you what they remember from yesterday – what was most interesting? Is there anything they want to ask about?

Help them to summarize what you did on the first day:

Mention the visual assessment of soil and its assessment by feel.

Mention the three components of soil texture.

Mention soil structure, soil colour, calculation of earthworms.

Mention the topic of application of chemical fertilizers and the topic of composting, including the composting of animal manure.

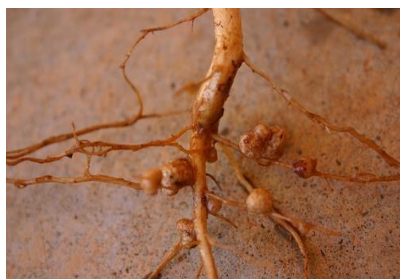
After you review all that has been said and done the day before, ask them **which other ways of improving soil fertility do you know?** Maybe they will mention some techniques not described in this curricula. If that is the case, discuss the techniques with them and make notes if some of the techniques are interesting and might not be well known to you.

Then draw their attention to the topic of **green manure**. This is the idea that **we improve soil fertility by cultivating some crops and then putting them back into the soil!** Why should such a technique improve the fertility of soil? The farmers might tell you that **crops take nutrients from soil** so growing crops actually depletes the soil. Explain to them that some crops do have the ability to improve soil fertility through nitrogen fixation.

TRAINING ACTIVITY 1 - DISCUSSION: THE CONCEPT OF GREEN MANURE

Nitrogen fixation

You should explain to them that, actually, **some crops fix nitrogen from the air into the soil and they fertilize the soil by this**. This is possible thanks to bacteria living on the roots of these crops. They are called **RHIZOBIA**. They take nitrogen from the air and fix it in a form that is accessible for plants in the soil.



Nodules containing nitrogen fixed from the air formed on roots of leguminous crops

Bacteria called rhizobia **form nodules on the roots of the plants**. They live in these nodules and fix nitrogen in them. So we can actually very easily see whether our plants fix nitrogen or not! We just have to look at their roots. You can scout for nodules on seedlings of leguminous crops **four to six weeks after their emergence from the ground**. Effective and viable nodules are pink or red when sliced open with a sharp knife. In dry periods, plants may fail to produce nodules or they can consume the nodules already produced. Nodules normally reappear when environmental conditions become favourable again.

Depending on the type of crop and conditions, **the amount of nitrogen fixed into the soil can be 8 – 40 kg per jerib**. That is not a small amount at all! Approximately half of that amount can be available to the following crop.

Discuss with the farmers which crops grown in Samangan are leguminous and should therefore fix nitrogen into the soil. Some of them are listed here:

Dari name	English name	Latin name
رشقه	Alfalfa	Medicago sativa
نخود	Chickpea	Cicer arietinum
نخود فرنگی	Pea	Pisum sativum
ماش	Mung bean (green gram)	Vigna radiata
سویا	Soybean	Glycine max
ماشک زمستانی (مشنگ)	Hairy Vetch	Vicia villosa
ماشک معمولی	Common Vetch	Vicia sativa
شبدر ایرانی	Persian clover	Trifolium resupinatum
شبدر قرمز	Red clover	Trifolium pratense
شبدر مصری	Egyptian clover	Trifolium alexandrinum

	Not commonly grown in Afghanistan:	
-دال نخود	Pigeon pea	Cajanus cajan
-ماش بنگالی	Sunn hemp	Crotalaria juncea



Sun hemp field for green manuring



Pigeon pea for green manuring

The idea of green manure crops is that we cultivate leguminous crops (possibly nitrogen fixing) but we do not let them become mature in the field. We break them and plough them into the soil while they are still green or soon after flowering. We do not let them reach the seeding stage! In this way the crops cannot drop their seeds. This leads to a very positive effect of minimizing weed growth in our field! Discuss the positive effects and challenges of the green manure with the participants:

Positive effects of green manure crops	Challenges regarding green manure crops
Nitrogen fixed by green manure crops will be available for other crops during the next season.	Obtaining, collection of seed and keeping the seed of green manure crops
Weed growth is minimized by green manure crops.	Additional labour needed to grow the crops and incorporate them into the soil
Structure of soil is improved by roots of green manure crops.	Ploughing the land and incorporating the green manure crops into the soil can be difficult
Water retention is improved	Water requirements of cover crops.
Pests and diseases are minimized	Waiting for decomposition for at least two – four months for next cultivation.
Microbial activity of soil is increased	<u>Sometimes the bacteria (Rhizobia) must be added in the form of inoculant so that nitrogen fixation process is started.</u>
pH of soil is slightly acidified	

Sometimes, even crops that do not fix nitrogen are cultivated as green manure crops. They still bring a lot of advantages for the soil quality (better structure, water retention) and they minimize weeds. The advantage of these crops can especially be that their seeds are cheaper. These crops are listed below:

Dari name	English name	Latin name
جو	Barley	<i>Hordeum vulgare</i>
بک ویت (از نوع پهن برگ ها است)	Buckwheat	<i>Fagopyrum esculentum</i>
ارزن دم روباهی	Foxtail millet	<i>Setaria italica</i>
ارزن معمولی	Proso Millet	<i>Panicum miliaceum</i>

Discuss the issue of SUSTAINABILITY of cultivation of green manure crops.

One disadvantage of green manure crops is that we cannot let them reach seeding phase to collect / harvest the seeds. We incorporate them into the soil in the green or flowering stage. This means that we cannot save the seed for next season. This can be avoided by a simple measure.

We leave a smaller part of the field where the green manure crops are sown to grow completely and to reach maturity. Then we will collect the seeds only from this small part of the field. That will keep our practice sustainable across seasons.

TRAINING ACTIVITY 2: OBSERVING NODULES IN LEGUMINOUS CROPS

Once all the participants understood the idea of nitrogen fixation as well as idea of green manure crops take them to the demo plot and evaluate several different kinds of green manure crops that you are growing on the demo plot. Make sure that different leguminous crops are grown there. Alfalfa and chickpea are especially resistant to drought – if varieties suitable for rain-fed land can be found. These should be experimentally cultivated also on a rain-fed demo plot. However, green manure crops will be mostly successful on irrigated land.

Take samples of seedlings from the fields and compare their root systems. When you find nodules, cut them in half with a knife. If they are pink or red inside, this means they are healthy and nitrogen is being fixed by them into the soil. Compare nodulation across different green manure crops' species, growing conditions, amount of irrigation water, fertilizers applied etc. Discuss with farmers which species in which growing conditions was most successful regarding nodulation.

TRAINING ACTIVITY 3 – DISCUSSION: TIME-PLAN FOR GREEN MANURE CROPS

Correct timing is essential for green manure crops cultivation. In general, we would sow them soon after harvest of the main crop – in July, August, September (in Samangan conditions). We will let the crops to grow for 2-3 months (depending on the crop and the stage of its growth – we can reach flowering stage but not seed formation). Seed should be formed only on a small piece of land designated for this. Discuss the cultivation calendar of different green manure crops and their connection to main crops cultivated by farmers. Which combinations go well together?

For example, it will be difficult to grow a green manure crop before sowing winter wheat as this is sown during autumn. The following crop calendar is recommended for Samangan province. However, the trainer should discuss a crop calendar with the training participants and take into account their experience.

Crop	Sowing	Incorporation into soil
Vetch ماش	May - June	After 2 months
Soybean سايبين	May - June	After 3 months
Different types of bean لوبيا	May - June	After 2 - 3 months
Hairy vetch مشنگ	May - June in spring October – November in fallow land in autumn season	After 3 months
Clover شبدر	May	After 2 months
Alfalfa رشقه	March – April for spring cultivation October – November for autumn cultivation	Any time but before seed setting.
Sainfoin قطره باران يا اسپرس	March – April for spring cultivation October – November for autumn cultivation	June, July onwards

TRAINING ACTIVITY 4: INCORPORATION OF GREEN MANURE CROPS INTO SOIL

Thorough incorporation of the crop is as important as its proper cultivation. Ideally, the crop should be first cut and left for few days (around 5) to wilt. After that it should be cut into pieces and mixed with the soil thoroughly. Ideally it should be buried under the soil with a plough.

In Afghanistan, proper ploughs that turn the soil are used only with tractors. These can be used also by farmers from the Farmer Field Schools (tractors can be rented), however it depends on the economic power of the farmer and the characteristics of his land. The wooden plough with metal cap (picture on the left) is usually used in rain-fed land with animal traction. Wooden plank is used for covering the seed (picture on the right).



These implements can be used for the incorporation of the green manure crop but will probably not be too successful. The wooden log will make the crop to bend and wilt and the plough can be used to mix the crop with the soil. However, the soil will not be turned.

Practically demonstrate the incorporation of green manure crops into the soil with the training participants. This is essential as the farmers are not used to incorporating crops into the soil and their implements are often not very suitable for that. That's why it should be tried out practically during the training and the best way should be discussed. The lead farmer or other farmers should bring some of the ploughing equipment with them to the demo plot.

FINAL ACTIVITY: QUESTIONS CHECKING LEARNING PROGRESS

Ask each participant at least one question and let them answer, explain to others and show it practically, without any interference from the trainers' side. After the participant answers, allow others to add their ideas or opinions or correct the answer if necessary. Give appropriate marks to the group response as indicated below. Calculate the total score after the training is finished and report it to your line-manager.

Q1: *How does the nitrogen fixation of leguminous crops work? Which crops have the ability to fix nitrogen into the soil? How much nitrogen can be approximately fixed per jerib by these crops? Show it practically with plants.*

Right answer: Leguminous crops have the ability to fix nitrogen from the air into the soil in cooperation with bacteria called Rhizobia living on their roots. In the process nodules are formed. Healthy nodules fixing nitrogen are pink or red inside when you cut them open. The crops do have to have the Rhizobia on their roots (inoculant can be added) and suitable conditions for growth in order to form nodules and fix nitrogen. They can fix as much as 8 to 40 kg of nitrogen per jerib. Examples of such crops are: Alfalfa, Chickpea, Pea, Mung bean (green gram), Soybean, Hairy Vetch, Common Vetch, Persian clover, Red clover, Egyptian clover, Pigeon pea, Sunnhemp and others.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know, unable to explain.	Knows the concept but unable to describe details and mention more than 2 examples of crops.	Knows the concept, describes in detail with some mistakes, knows at least 3 examples of crops.	Knows the concept, describes in detail without mistakes, knows at least 5 examples of crops.

Q2: *What are the advantages of using green manure crops? What are the challenges? Name at least three advantages and two challenges.*

Right answer:

Positive effects of green manure crops	Challenges regarding green manure crops
Nitrogen fixed by green manure crops is available for other crops during the next season	Obtaining and keeping the seed of green manure crops
Weed growth is minimized by green manure crops	Additional labour needed to grow the crops and incorporate them into the soil
Structure of soil is improved by roots of green manure crops	Ploughing the land and incorporating the green manure crops into the soil can be difficult

Water retention is improved	Water requirements of cover crops.
Pests and diseases are minimized	Waiting for decomposition for at least two – four months for next cultivation.
pH of soil is slightly acidified	Sometimes the bacteria (Rhizobia) must be added in the form of inoculant so that nitrogen fixation process is started.
Microbial activity of soil is increased	

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know, unable to explain.	Knows only one advantage or challenge.	Knows at least 2 advantages and 1 challenge.	Knows at least 3 advantages and 2 challenges.

Q3: *How can we make the cultivation of green manure crops sustainable? How do we obtain the seed? Name the cropping calendar for at least 2 crops used as green manure.*

Right answer: We make it sustainable through leaving a small part of the field with the green manure crop to mature and provide seeds for the next season. Cropping calendars are available above.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know, unable to explain.	Knows how to keep sustainable but doesn't know cropping calendars.	Knows how to keep sustainable and knows one cropping calendar.	Knows how to keep sustainable and knows two or more cropping calendars.

Q4: *What is most important while incorporating the green manure crop into the soil?*

Right answer: To cut the crop and let it wilt for around 5 days, to mix the crop thoroughly with the soil and to turn the soil so that the crop is under the soil.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Don't know, unable to explain.	Knows one important point.	Knows two important points.	Knows three important points.

Total Points Received:

_____ OF 12 POINTS or _____ %