

Part 5

Soil

worksheet 5.1

Improving the soil – getting started with green manure

In Permaculture we believe that we do not farm plants and animals, but that we farm the soil. All of our needs come from the soil and so we need to develop healthy soil in order to grow healthy food.

Green manures are fast-growing plants that we plant on a piece of land to improve soil fertility and to protect the soil from erosion. Green manure plants may be legumes and non-legumes. They are normally low, spreading plants that grow fast and cover the soil surface quickly after planting. During or after the growing season, the green manure plants are cut and dug into the soil. They then decompose into humus and release nutrients and so improve the soil.

Green manures conserve and improve the soil in several ways:

- Legumes take nitrogen from the air and fix it in a form they can use. Once dug into the soil, the legumes decompose and the nitrogen becomes available to other plants grown there.
- Green manure crops prevent the soil from being washed away by rainwater or blown away by wind.
- The green manure crop protects the soil from the direct heat of the sun, helping it retain moisture.
- Green manure crops quickly cover the soil and so help to control weeds.
- The green manure crop can be grown as a pure stand, so it enriches the soil for other crops to be grown in the next season. It can also be grown as an intercrop between rows of another main crop, such as maize, sorghum and millet, or beneath fruit trees.



A green manure crop can be grown as a pure stand.

A green manure crop can also be grown as an intercrop between rows of another maincrop



Common legumes used for ground covers/living mulches are cowpeas, vetch, red clover and lupins. Green manures can also be non-legumes such as barley, ryegrass, pumpkins and mustard. All these crops are grown in summer, except for ryegrass, lupins and barley, which can be grown in winter.

Activity 5.1



Group work

Planting a green manure crop

Each group will need

tools for clearing the land, digging and levelling the soil (garden forks, spades, hoes, rakes); ground cover legume seeds; *Rhizobium* inoculant for the seeds; a way to water the seeds (watering can, hosepipe)

1. Each group will sow an area with legume seeds. Your teacher will tell where your area is.
2. You first need to prepare your area. Clear any unwanted plants growing on the area. You can do this by pulling or digging them out of the ground. Pile the removed plants nearby to be made into compost later.
3. Dig over the soil with a garden fork, spade or hoe. Move backwards when you work so you do not stand on the area you have just dug.
4. After digging, use a rake to break up the soil lumps. For bigger areas, farmers and gardeners use rotary hoes, which run on petrol.



Dig over the soil with a garden fork, spade or hoe

Part 5: Soil

worksheet 5.1 Improving the soil – getting started with green manure

During the establishment of a school Permaculture food garden, the planting of green manure crops serves to expand the cultivated area of a garden by beginning to prepare the soil for planting in later years.

Activity 5.1 Planting a green manure crop

Work in groups

The purpose of this activity is to establish an area of the school garden with a legume green manure crop.

Each group will need

tools for clearing the land, digging and levelling the soil (garden forks, spades, hoes, rakes); ground cover legume seeds; *Rhizobium* inoculant for the seeds; a way to water the seeds (watering can, hosepipe)

Legume seeds and *Rhizobium* inoculant for the seeds are available from farmer supply shops which you find in most small towns. Land clearing tools are not frequently needed in a Permaculture garden, so you could get learners to bring tools from home rather than buying such tools for sole use in the school garden.

Answers to questions

The functions of a legume cover crop (green manure crop) include:

- Legumes take nitrogen from the air and fix it in a form they can use. Once dug into the soil, the legumes decompose and the nitrogen becomes available to other plants grown there.
- Green manure crops prevent the soil from being washed away by rainwater or blown away by wind.
- The green manure crop protects the soil from the direct heat of the sun, helping it retain moisture.
- Green manure crops quickly cover the soil and so help to control weeds.

Curriculum Links

Outcomes

CO2: Work effectively with others as members of a team, group, organisation and community.

CO3: Organise and manage themselves and their activities responsibly and effectively.

CO6: Use science and technology effectively and critically showing responsibility towards the environment and the health of others.

Assessment

Assess the answer to the activity question. You can also assess one or more of the critical outcomes listed above.

worksheet 5.2 Improving the soil – sheet mulching

Activity 5.3 Sheet mulching your garden

Group work

Each group will need

slashing tools, newspapers, cardboard, agricultural lime, bonemeal, chicken manure, seed-free dried grass or straw, good compost or well-rotted manure, vegetable seedlings.

Other materials you can use for sheet mulching include: old carpets, carpet underfelt, old mattress/clothing, horse-stable straw, poultry manure in sawdust,

seagrass or seaweed, leaf mould or raked leaves, pine needles, nut shells, leaf mould or raked leaves, bark, chips or sawdust.

This activity involves learners in the work of establishing the fertility needed for a food garden. Sheet mulching also conserves water and control weeds.

You need to collect sheet mulching materials before learners do this activity. Here are some ideas:

- Send each learner home with a letter to their parents asking them for materials for the school food garden. These materials can include building rubble, such as bricks, or any other material that would be suitable to line paths; newspapers and cardboard.
- Get involved in the waste disposal systems at the school. All garden waste should be piled in one place to be composted. This could be used for sheet mulching.
- Contact local sawmills, horse stables or poultry farmers to get untreated sawdust or manure delivered to your school.

There is also a need for teachers to do the garden design beforehand. This involves deciding where beds and pathways should go. Mark out the shape of the garden. With the learners help, mark pathways with bricks or stones, and put cardboard in the pathways. Include chicken fodder in the garden design by allowing for the positions of a chicken tractor, fodder legumes, fodder trees, etc.

Curriculum links

Outcomes

CO2: Learners work effectively with others as members of a team, group, organisation and community.

CO6: Use science and technology effectively and critically showing responsibility towards the environment and the health of others.

NS LO3: Learners demonstrate an understanding of the interrelationship between Science and the environment.

Assessment

This activity gives a good opportunity for assessing CO2: Learners work effectively with others as members of a team, group, organisation and community.

Activity 5.3 Investigate the effect of mulching soil moisture

Home activity

1. This activity should demonstrate to learners how mulched soil stays wet for longer than soil with no mulch. It is a basic investigation in which they need to compare the wetness of two identical areas of soil when one is mulched and the other is unmulched. For this to be a fair scientific test, all the conditions, other than the mulch, should be exactly the same.
2. This activity looks at the mineral component of the soil. Its main purpose is to make learners aware of the length of time it takes for soil to form and, therefore, of the importance of conserving and improving soil.

Answers to questions

Weathering agents include:

1. Temperature changes

High temperatures in the day cause rocks to expand. To expand is to get bigger. Low temperatures at night cause rocks to contract. To contract is to get smaller. The expansion and contraction of rocks over a long time causes them to crack and break into smaller pieces.

2. Running water

When water flows in streams and rivers, stones are moved and rubbed together. Small pieces of rock break off. After hundreds of years these pieces become soil.

3. **Rain**
Falling rain slowly weathers rocks.
4. **Waves**
At the places where the ocean meets the land, large waves of water hit against the land. Waves that hit against rocks cause the rocks to slowly wear away. Waves also carry small rocks backwards and forwards so that they rub against one another and slowly break up into soil.
5. **Wind**
Wind carries small particles of soil. When wind blows against rock the soil particles beat against the rock and slowly wear away the rock to form more soil.
6. **Plants**
Mosses and lichens are tiny plants that grow on the surface of rocks. This causes the rocks to break up into smaller pieces. The roots of trees that grow along rocks cause them to crack.
7. **Animals**
The movement of animals over rocks over a long period of time weathers them to soil.

Curriculum Links

Core knowledge and content

NS Planet Earth and Beyond

Soil consists of weathered rocks and decomposed organic material. Soil forms by natural processes, but it takes an extremely long time to form.

Outcomes

NS LO1: Learners conduct investigations and collect and evaluate data and communicate their findings.

NS LO2: Learners know, interpret and apply scientific knowledge.

CO4: Collect, analyse, organise and critically evaluate information.

CO5: Communicate effectively using visual, symbolic and/or language skills in various modes.

Assessment

1. Assess the written report giving the aim, method, observation and conclusion of the investigation.
2. Assess the written essay about weathering agents.

worksheet 5.3 Improving the soil – worm farms

Activity 5.4 Keep a worm farm

Class work

Schools have immense success with their worm farms as a cheap and easy means of getting rid of organic waste and creating excellent fertiliser. The aim of this activity is to establish a worm farm for the school food garden. Once established, there will be ongoing maintenance work to feed the worms with plant waste. As the population of the worms increases, they can be removed to start new worm farms and to introduce worms to new areas of the garden. The questions at the end of the activity link worms to the sense organ content of the curriculum.

You will need

- A container for the worm farm. There are many types of suitable containers for keeping worms, including simple polystyrene or wooden boxes from the shops, an old metal drum, an old bath tub or old tyres. There must be holes in the base of the container to let water drain out.
- Two or more bricks to raise the container off the ground so that water can drain out easily.
- At least 2,000 compost worms. These worms will breed and multiply to about 8,000 worms in 6 months. To obtain worms to start your worm farm, speak to people from SEED or other Permaculture projects.

- Organic starter material, which can include partly decomposed compost, straw, grass clippings, shredded paper, fruit and vegetable waste or leaf mould. There should be enough to half-fill the container.
- A loose cover, such as Hessian sacking. If you do not have hessian, you could use a sheet of cardboard or even a whole newspaper.
- Grit – a mixture of soil and sand, needed by earthworms for digestion.

Answers to questions

1. a) Encourage learners to watch the worms and see what the preferred foods are before answering this question.
2. a) Earthworms do react when you take off the cover. They move away from the light.
b) The five senses of people are sight, smell, touch, hearing, taste.
c) Earthworms moving away from light suggests that they must have sense receptors that are sensitive to light.

Curriculum Links

Core knowledge and content

NS Life and Living

All living things can respond to their environment in various ways; animals, including humans, have specialised sense organs.

Outcomes

NS LO2: Learners know and are able to apply scientific and environmental knowledge.

CO2: Work effectively with others as members of a team, group, organisation and community.

CO3: Organise and manage themselves and their activities responsibly and effectively.

CO6: Use science and technology effectively and critically showing responsibility towards the environment and the health of others.

Assessment

Assess the answers to the activity questions. You can also assess the critical outcomes.

worksheet 5.4 Setting up soil fertility systems – mulch banks

Activity 5.5 Investigate the causes of erosion

Class work

You will need

a tin with holes in the bottom, 3 plastic containers, 3 of the same types of boxes such as shoe boxes or a large washing powder box, 9 bricks, soil, sods of grass, fallen leaves from under a tree

The aim of this activity is to cover the Natural Science core content about soil erosion. The activity demonstrates how bare soil promotes soil erosion, while ground cover prevents it. Soil erosion is taught at the same time as mulch banks because mulch banks can play an excellent role in preventing erosion as well as acting as a source of mulch and composting material. You can set up the equipment for this activity as a permanent demonstration in the food garden. To do this, it is better to raise the equipment above ground level so that people can easily see it and do not trip over it.

Answers to questions

- a) The least soil should have collected in the container where the soil was covered in grass.
- b) The most soil should have collected in the container that had no soil cover.

- c) The least water collected in the container where the soil was covered in grass.
- d) The most water collected in the container that had no soil cover.
- e) One brick in front of the box, but two bricks at the back of the box gives the box a slope to behave like sloping ground.
- f) The activity shows that ground cover reduces erosion and the run off of water.

Curriculum Links

Core knowledge and content

NS Planet Earth and Beyond

Erosion of the land creates landforms that we see and also results in deposition of rock particles that may be lithified to form sedimentary rocks. Erosion and deposition can be very slow and gradual or they can occur in short catastrophic events like floods.

Outcomes

NS LO1:Learners conduct investigations by carrying out instructions involving a small number of steps. They then evaluate their data and communicate their findings.

Assessment

Assess the answers to the activity questions.

worksheet 5.5 Improving the soil – compost

Activity 5.6 Make compost

Class work

This activity involves learners in the ongoing work of establishing the infrastructure of a food garden. It also teaches the theory and practice of compost making which can be continued in their home situations as means to reduce waste and improve gardens.

Curriculum links

Outcomes

CO2: Work effectively with others as members of a team, group, organisation and community.

CO3: Organise and manage themselves and their activities responsibly and effectively.

CO6: Use science and technology effectively and critically showing responsibility towards the environment and the health of others.

Assessment

You can also assess one or more of the critical outcomes listed above.

Part 6: Water

worksheet 6.1 Using the water cycle

Activity 6.1 Investigate transpiration

Work as a class

You will need

a clear dry plastic bag, a piece of string

This activity demonstrates that transpiration – the loss of water from the leaves of plants – does take place. It is best to do this activity on a warm sunny day.