



What is Soil Conservation & Improvement ?



All plant life needs soil to germinate, grow and live its life. If the soil and soil management is good, farm production will also be good. The condition of our environment, society



Bare land becomes greener as the soil recovers in Surkhet, Nepal

and economy all depend on the health of the soil. If the soil can be kept fertile, production increases, the local economy is strong, and society is safe.

Just like skin covers our bodies, so soil covers the Earth. Just like our bodies are damaged if our skin is broken, or wounded, so the Earth is harmed, and production decreases if the soil is damaged or washed away. If the soil is damaged, the farming community also suffers great harm. So we need to understand the needs of soil, and what can damage it. This chapter also gives information on how soil can be sustainably protected and improved.

Soil and its Needs

Different climates have different types of soils . Often, one type of climate will also have many different types of soil. But whatever the soil, they all have similar ingredients in them. Such as :-

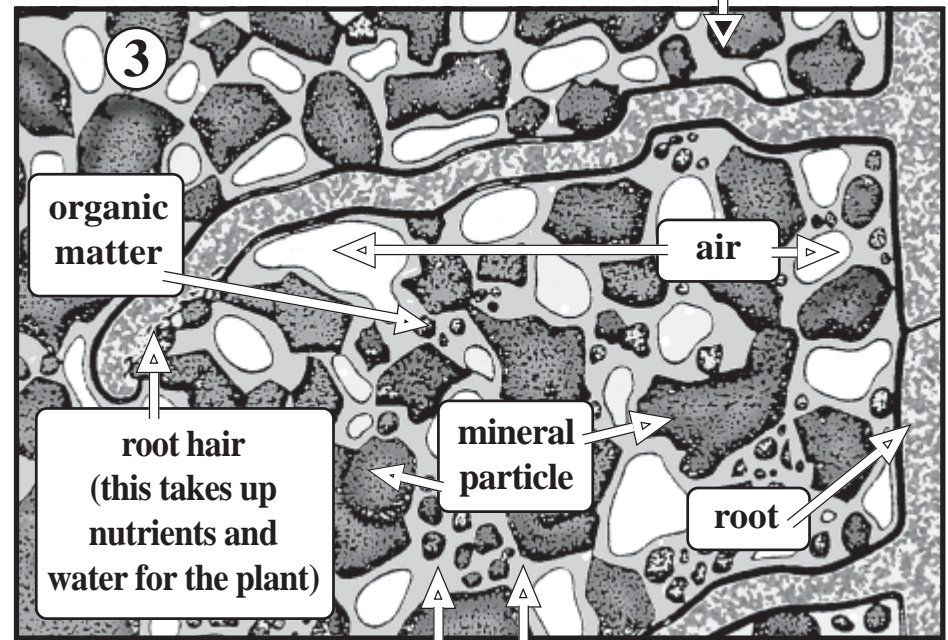
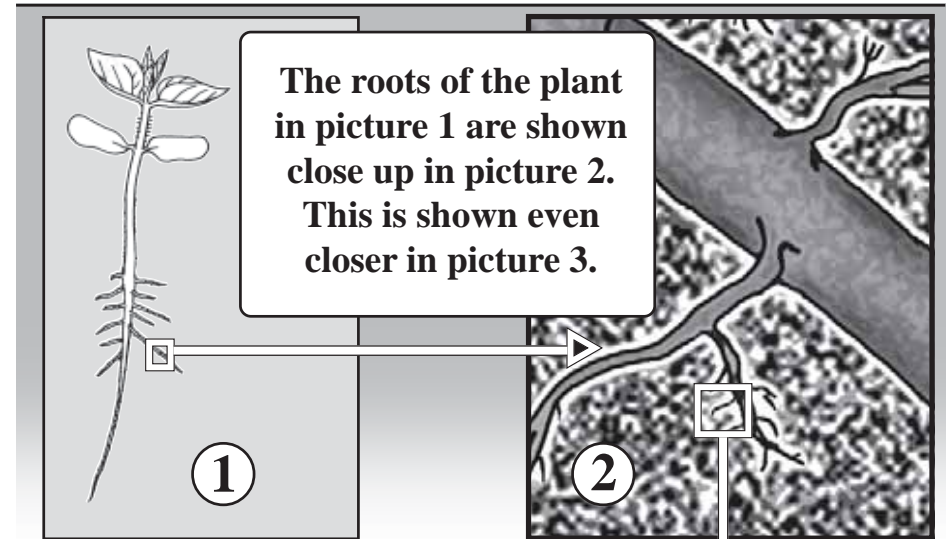
- **mineral particles** - these forms the main part of soil
- **air**
- **moisture (water)**
- **animal life** (visible and microscopic)
- **roots of living plants**
- **organic matter** (dead plants and animals that are in the process of being broken down)



Fertile soil gives good production for all the farm's crops

The ingredients listed above are found in all soils in a greater or lesser amount. When they are in the right amount, the soil is naturally fertile.

This booklet's author
Chris Evans, advisor,
Himalayan Permaculture Centre, Nepal
www.himalayanpermaculture.com



Everything else is soil water, or moisture. In the water are many nutrients, and countless microscopic organisms are also active in this water.

According to the soil type, these different elements are present in different amounts. For example, let's compare sandy and clay soils.

Sandy Soil

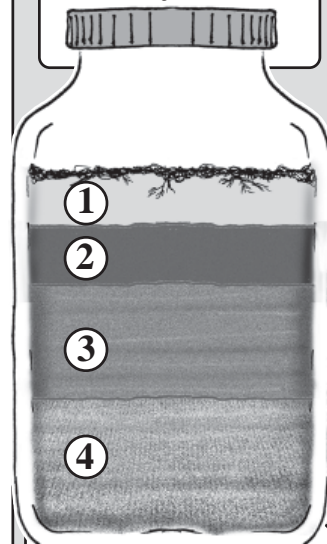
- mineral particles are large
 - air spaces between the mineral particles are large
 - lots of air in the soil
- As a result of this :-**
- soil is light and well aerated
 - the soil doesn't hold water, and dries out faster
 - nutrients are washed out quickly

Clay Soil

- mineral particles are small
 - space between the particles is small
 - less air in the soil
- As a result of this :-**
- the soil is heavy
 - as soon as it rains, the soil is saturated and stays wet for a long time. But when it dries, the soil is very hard
 - nutrients are held in the soil but if there is less air in the soil, plants can't get the nutrients so easily

Testing Soil

Put a handful of soil in a jar of water and shake well. Leave it to settle for 4-5 days. The different types of mineral particles will settle into separate layers

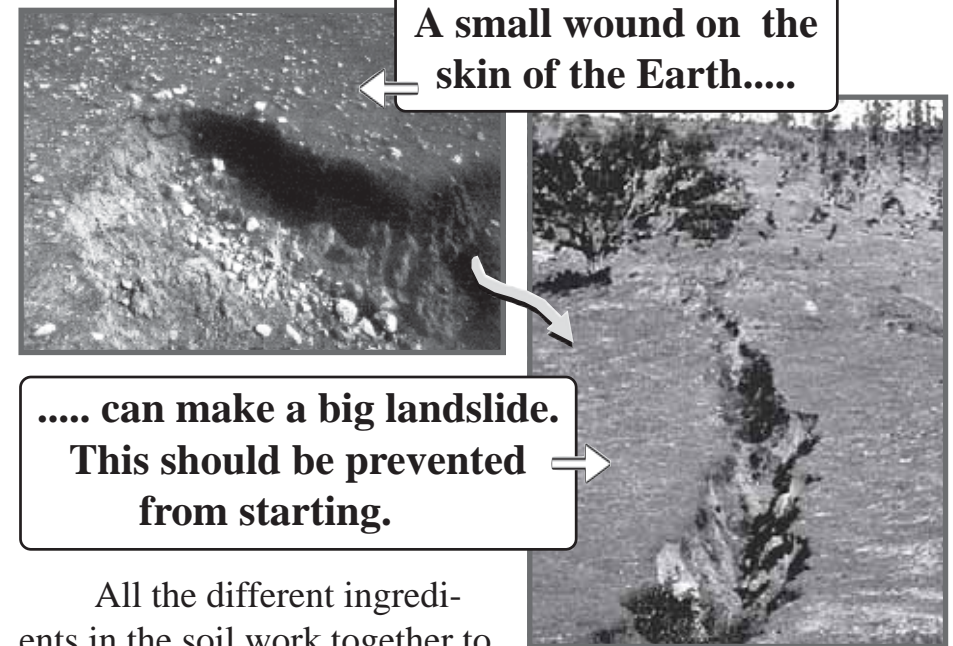


1. Organic matter
2. Clay particles
3. Loam particles
4. Sand particles

Needs of the soil

What is needed to protect and maintain fertility in the soil ?

The contents of the soil described above - air, minerals, organic matter, living roots, moisture and living organisms - are all essential in the right quantities for healthy soil. When they are all present, soil is naturally self-fertile. Adding the right quantities as needed also maintains the quality of the soil. But if any one ingredient is present in a lesser or greater amount than normal, the quality of the soil can be harmed, or it can also be improved.



A small wound on the skin of the Earth.....

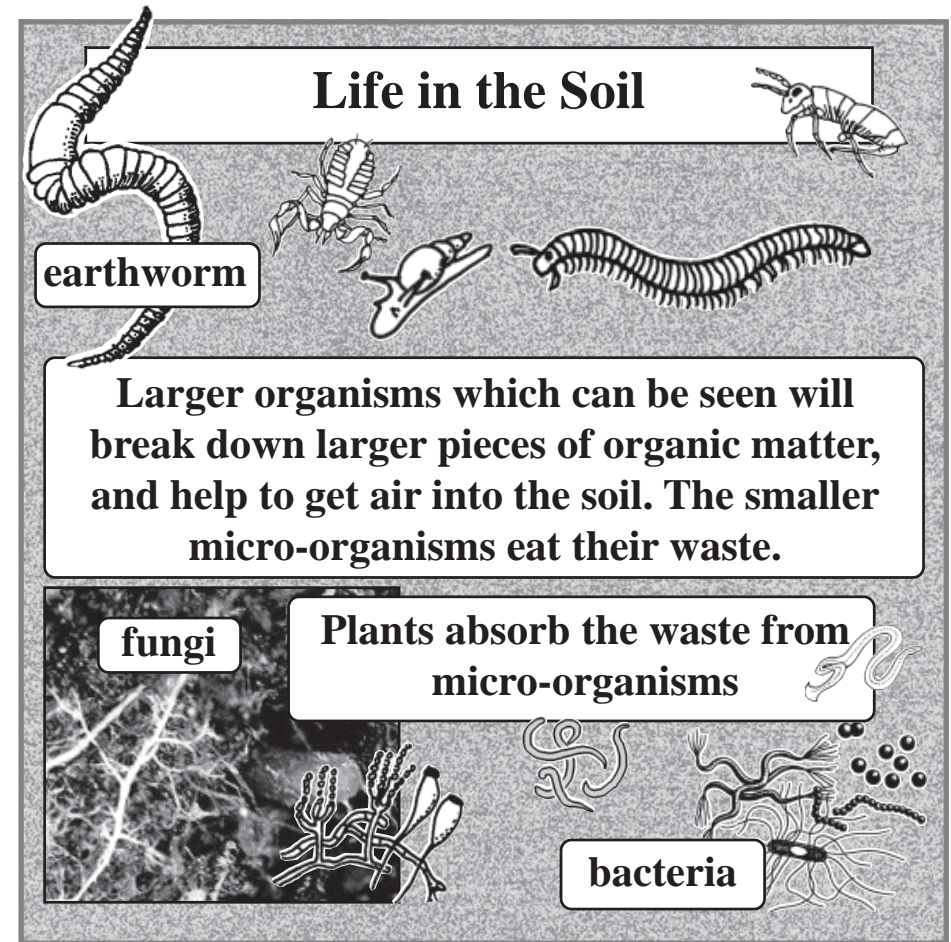
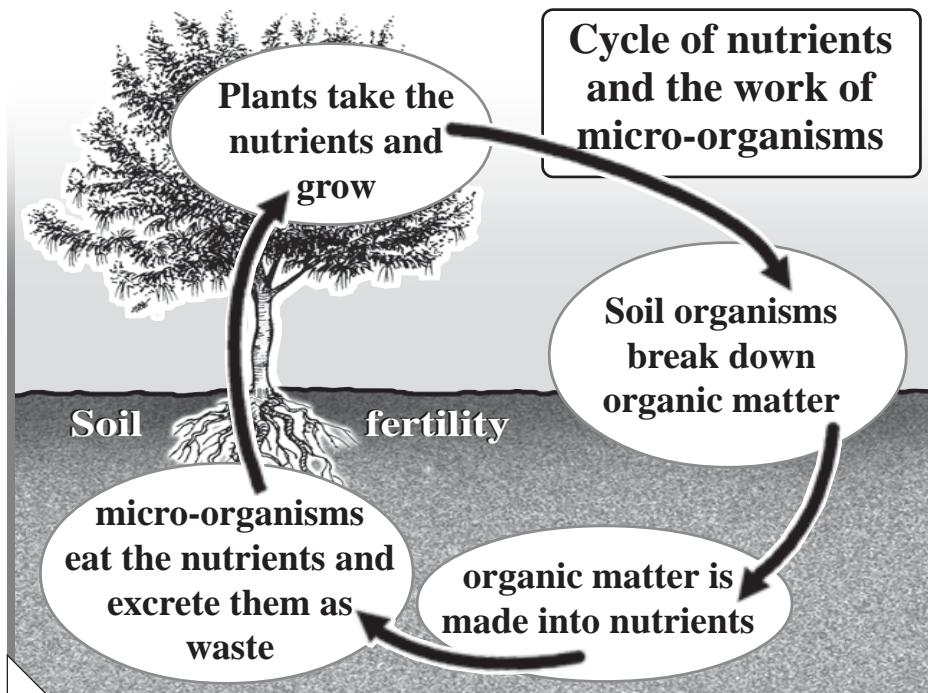
..... can make a big landslide. This should be prevented from starting.

All the different ingredients in the soil work together to help plants to grow. But more important than these minerals, living roots, organic matter, etc. are the living organisms in the soil. In particular, the tiny, invisible organisms, such as bacteria, and fungi play a huge role in maintaining and increasing soil fertility. These are collectively called **micro-organisms**.

Soil life and micro-organisms

Actually, micro-organisms are probably the most important life on our planet. Living in one teaspoon of fertile forest soil there are **2 billion** micro-organisms. Larger organisms, and many types of fungi are also responsible for breaking down dead plants and animals. This forms **organic matter**. Then, the smaller micro-organisms - mainly **bacteria** and **fungi** - take the organic matter and change it so plant roots (the root hairs) can absorb the nutrients, as we cook bread from flour. Even if there is plenty of organic matter in the soil, without the work of micro-organisms, this cannot be taken up by the roots of living plants until it is "cooked".

Leaves and branches, dead animals, etc. fall on the soil and are broken down. Micro-organisms eat them. Then, it is their waste in the soil which plant roots absorb as nutrients. This allows the plants to grow and continue the cycle of life.



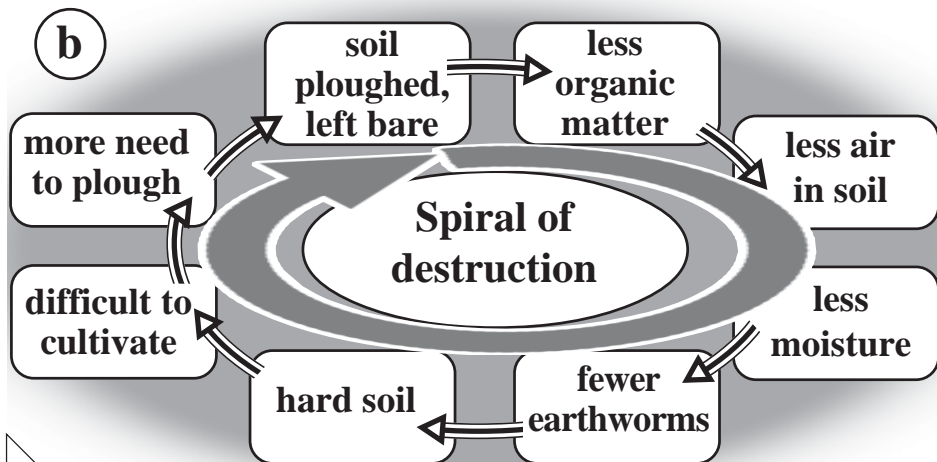
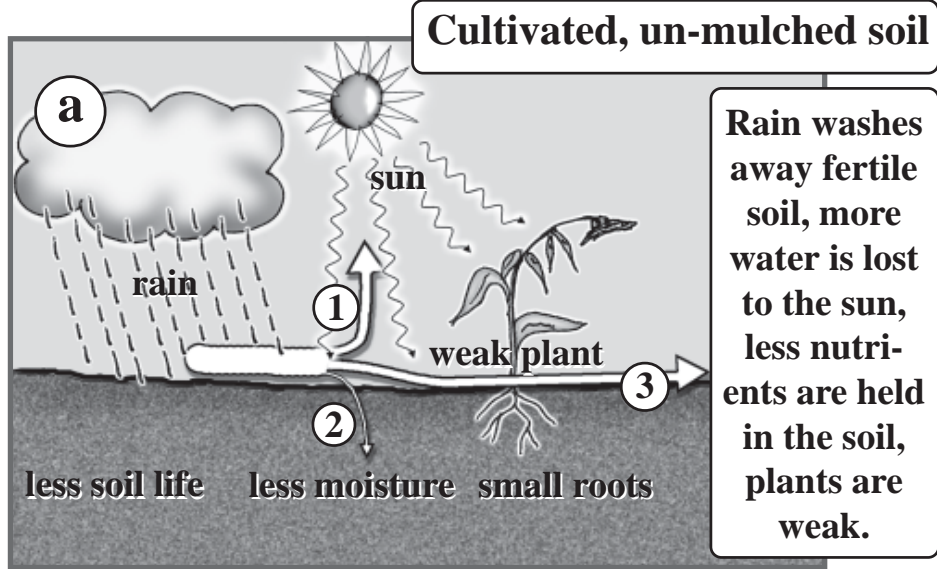
How soil is damaged

When soil is left bare, it can be damaged very easily. Many things can damage bare soil, such as :-

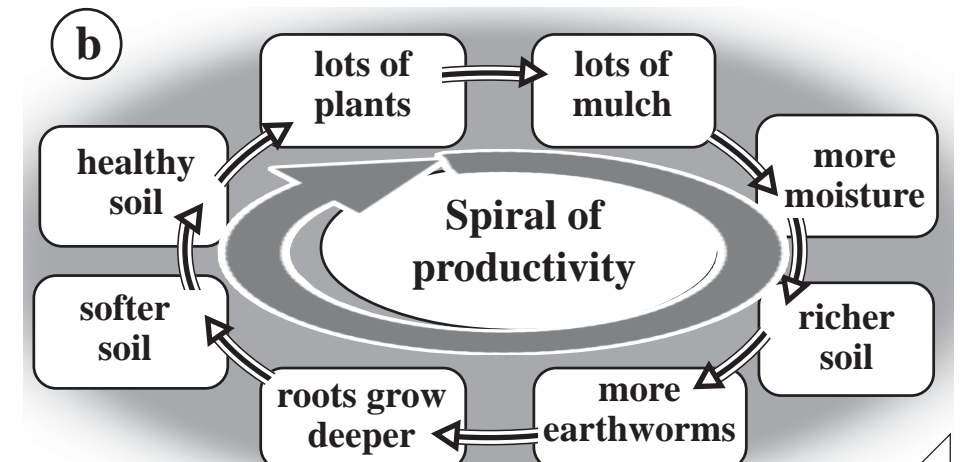
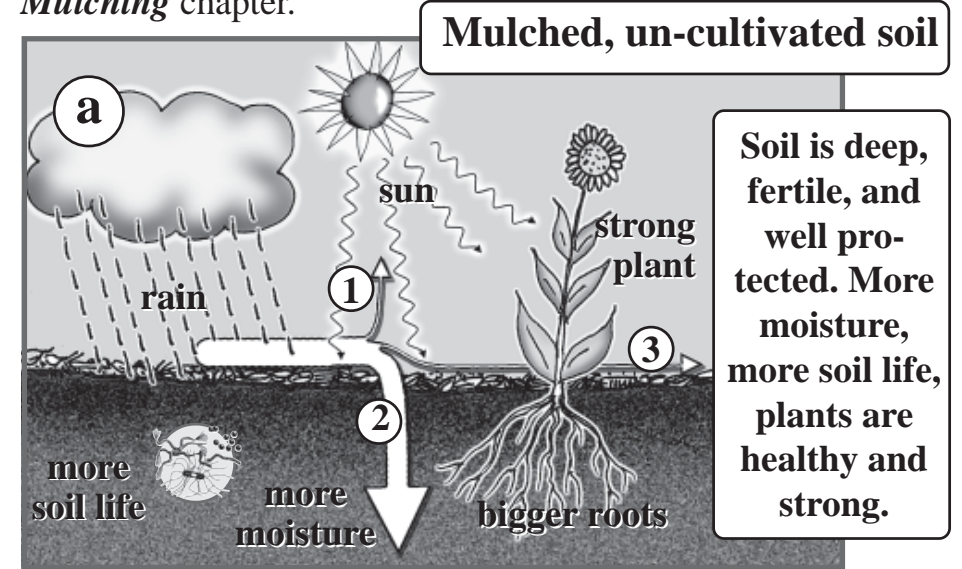
- **sun** :- strong sun will dry out the soil. Dry soil hardens and cracks the soil. Micro-organisms will die in dry, hard soil.
- **water** :- when it rains on bare soil, the top layer will set hard. On slopes, the topsoil is washed away downhill.
- **wind** :- wind will dry out all the moisture from bare soil, and can actually blow the top soil away.

Comparing soil with and without mulch

On these 2 pages the effects of mulching and not mulching are compared together. The left page diagram (a) shows what happens with no mulch on the soil, while the right page diagram shows the example of a mulched soil. The top diagram shows water ① lost to evaporation, ② running off the soil, and ③ soaking into the soil. The cycle below each drawing also shows the effects of mulching or not mulching on soil quality.



Protected from the sun, wind and rain, the organic matter, soil moisture and beneficial micro-organisms all benefit from mulching the soil. You need to consider where resources for mulching can be found, such as leaf litter, straw, etc. Leaves can be brought from the forest, but this takes time. To produce more resources for mulching, its best to use *Agroforestry* and a *Living Fence* - see these chapters for more details. Learn more about the methods and benefits of mulching in the *Mulching* chapter.



Other things which damage the soil








- **Chemical fertilizers** :- these harm the soil micro-organisms and so cause the soil structure and nutrient uptake to be damaged.
- **Artificial poisons** :- as well as killing pests, these kill many beneficial insects and organisms which work in the soil.
- **Big, heavy machinery** :- big machines such as tractors compress the soil so that there is less air space. They destroy the structure of the soil, as well as damaging soil organisms.
- **Large livestock** :- on wet soil, the feet of large livestock such as cows and buffaloes also compress the soil and damage soil structure.

Nutrient management for plant growth

Symptoms of lack of certain nutrients

<i>Symptoms seen on mature leaves</i>	<i>lack of</i>
Leaves yellow, starting from tips	nitrogen
Leaves die from the edges	potassium
Leaves yellow between the veins	magnesium
Grey/white spots on fruit and grain	manganese
Leaves and stems turn red colour	phosphate
<i>Symptoms seen on young leaves</i>	<i>lack of</i>
Yellow spots on leaves & veins yellow	sulphur
Yellow spots on leaves & veins green	iron
Grey spots on seed, pods and fruit	manganese
Newest leaves die back or have white tips	copper

So, what to do if nutrient deficiencies are recognised by these symptoms ? The chart below gives examples of plants which accumulate greater amounts than usual of certain nutrients. These can be used in mulch, compost or liquid manure so those nutrients which are lacking can be added to the soil. They are called *dynamic accumulators*.

plant	contains lots of
mustard	phosphate, nitrogen, iron 
buckwheat	phosphate 
carrot (leaf)	potassium, magnesium 
comfrey	nitrogen, potassium, magnesium, iron 
legumes	nitrogen 
marigold	phosphate 
nettle	nitrogen, potassium, iron, sulphur, copper 
amaranth	nitrogen, phosphate, potassium, manganese

The main thing to consider in soil conservation and improvement :-

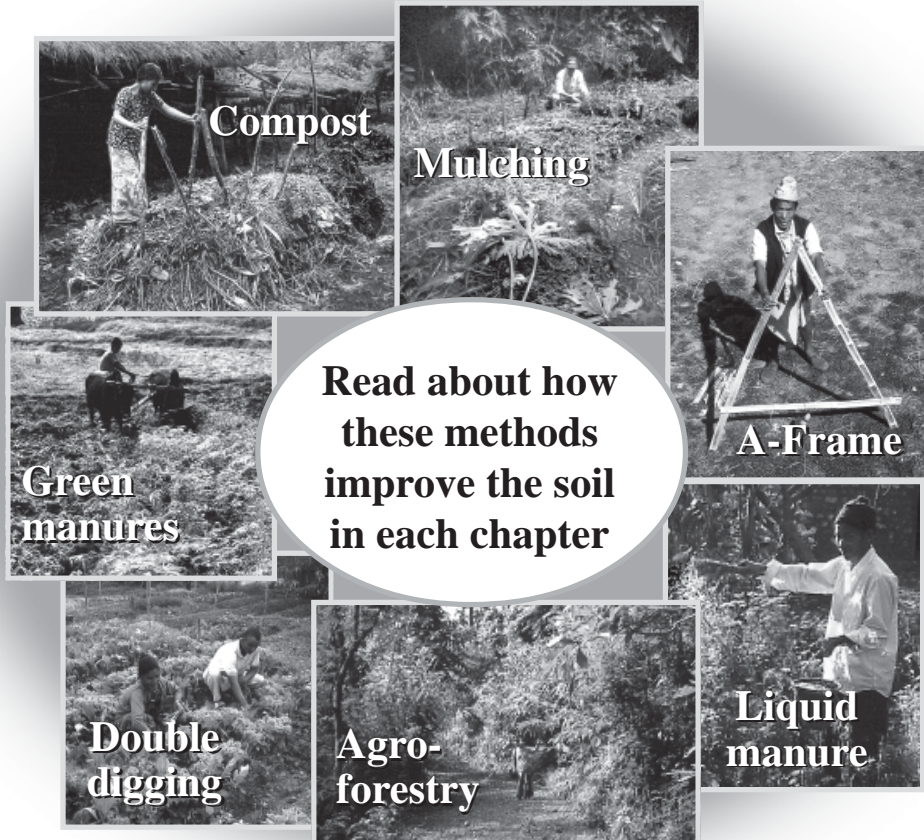
We need to understand what benefits the soil as well as what that damages the soil, and plan our work according to this.

There are 3 main strategies :-

1. We need to **feed** the soil micro-organisms, and allow a **good habitat** for them to live and work in.
2. The soil should not be bare. We need to keep it **covered** as much as possible. Especially, take care to cover and protect the soil when there is strong sun, rain and wind.
3. Stop water from **running off** down a slope for any distance - it runs faster, and carries off much soil and nutrients with it.

Methods of soil conservation and improvement ?

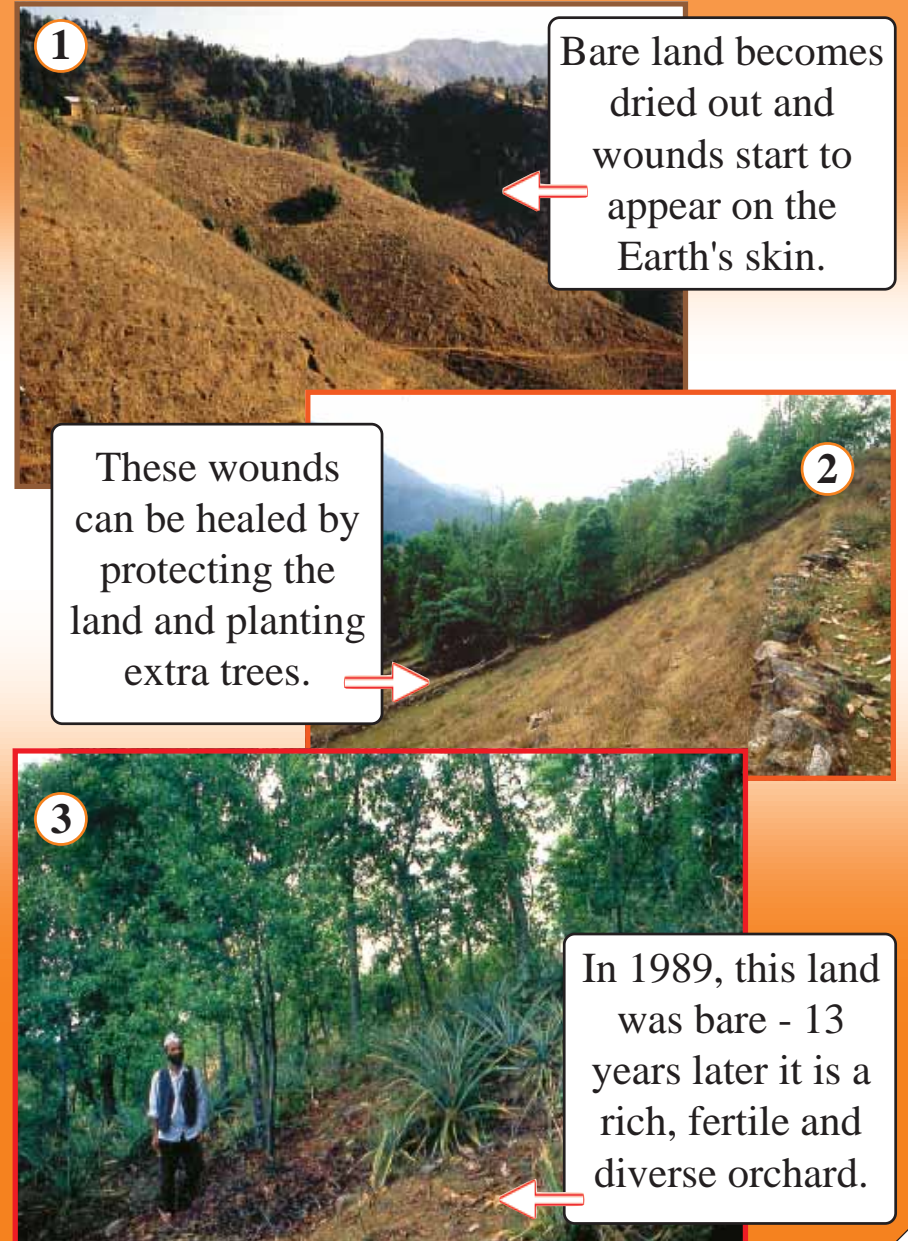
1. **For the micro-organisms :-** mulching, good compost, liquid manure, green manures, agroforestry, afforestation.
2. **To cover the soil :-** mulching, green manures (when land is fallow), agroforestry, afforestation, etc.
3. **To stop water running off :-** mulching, green manures, agroforestry, afforestation, use A-frame to make contour ditches, terrace maintenance.

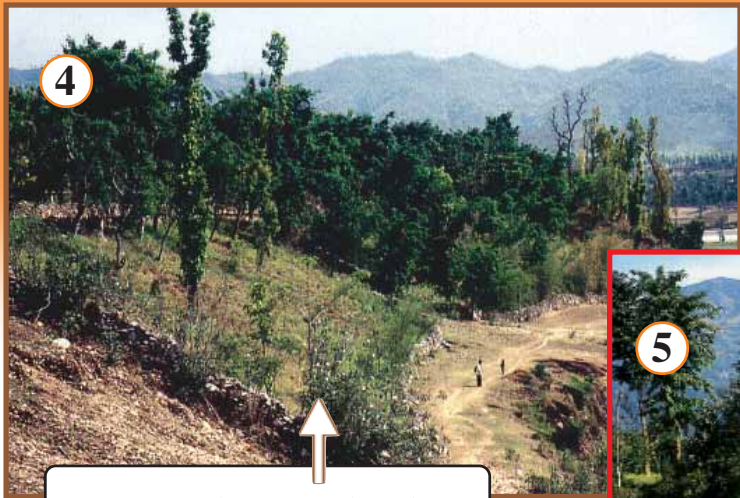


In this chapter, up till now we have read about soil, what it needs and how we can increase its fertility. Now, we look more at regeneration of damaged soil.

Let's See

how to conserve and improve the soil

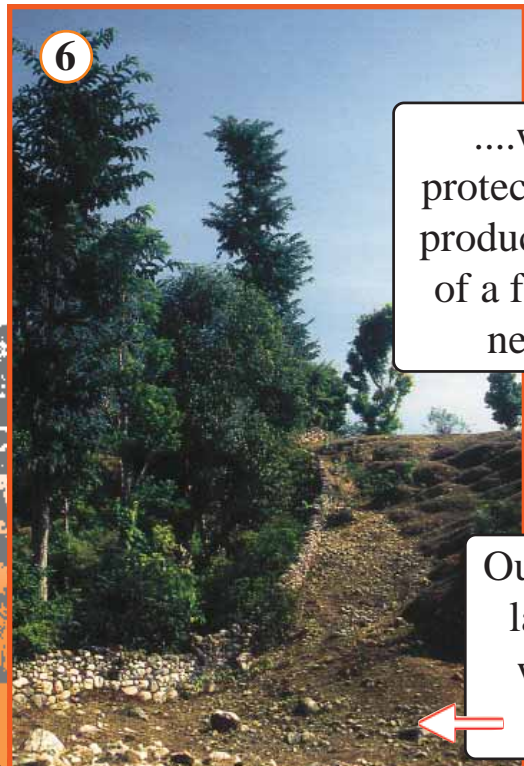




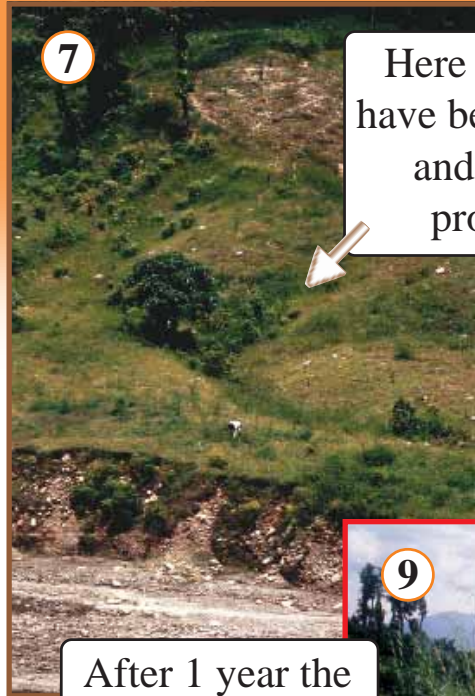
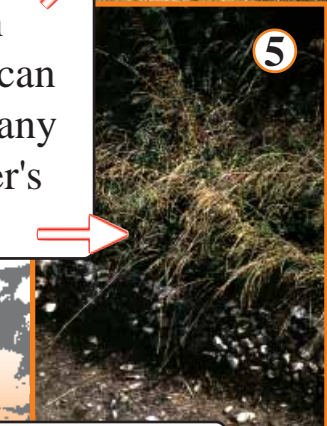
Bare and unproductive land on the river edge....



....when protected, can produce many of a farmer's needs.



Outside the wall the land is degraded, while inside has grown green



Here seedlings have been planted and the site protected



Napier grass planted



After 1 year the Napier is big enough to cut for fodder



Ipomea (Morning Glory) planted on the river bank to prevent erosion

11



A high altitude Resource Centre farm being started in 1990 in Jajarkot, Nepal

The canal, made using an A-frame, allows the water to infiltrate the soil

12



This means bare land improves very quickly (this picture in 1993)

13



Maize stalks are used to strengthen the terrace and stop soil erosion

Repair of Damaged Land

Up until now in this chapter, information has been given to assist in good soil management. If there is good soil on the farm, it is not difficult to maintain and increase soil quality. Where soil has become degraded, the difficult work is to improve it again. But this is very important work - no community can claim it is poor as long as it has degraded land in its region, because they can improve productivity simply by repairing this land.

All the things discussed above will help in the repair of damaged soil. But before putting much work into land regeneration, we should first understand how nature does the job.

This is a poor village. No forest, no soil, no wealth.



But the ability to improve the land is in the community's hands. Nature also wants to improve itself.

Soil Improvement and Succession

Improving the soil doesn't take so much work. It's often enough just to prevent it degrading. Left alone, soil will gradually improve itself, in a process called *succession*. For example, when any bare land is protected, special ground cover plants called *pioneers* will start to grow first. They will start the soil improvement process. Then, larger shrubs and trees will start to grow. Eventually, a mature forest will develop, and the soil will get a new life.

So the first need for improving the soil is protection. The easiest type of protection is a "**community fence**" - the community decides to protect an area of land, and prevent livestock going into it. After that, stone walls, thorny brush, etc. can be used to make a fence. Most difficult is the individual protection of trees, by surrounding them with thorny branches.



Communally protected land grows through *succession*



A walled area



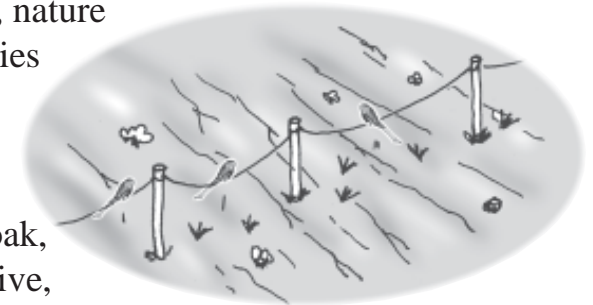
Each tree is protected by thorny branches

The seeds of many pioneer plants are already in the soil. Many types of fruit, such as *Ficus*, mulberry, etc. are eaten by birds and spread on the land through their manure.

We can speed up this process by providing perches over a bare area for birds to sit on. Bury tall posts on a contour line, and tie string between them. Under the string where birds sit, the seed they carry will germinate.

On bare land, it's much easier to work with nature. With a few years' protection, nature will plant the best species to improve the soil.

Then people can plant the larger species they need, such as walnut, oak, etc., and they will survive, and grow much better.



This improvement doesn't cost much and the land will improve sustainably. The right plants will grow according to site and climate. Making a plantation on a bare site is very expensive, and more trees will fail. It's much cheaper and more effective to use *succession* for soil improvement.

Land improvement - who benefits?

The aim of improving community land is to prevent erosion, and produce more fodder, firewood, etc. But we must consider who benefits from this work. There are many examples where resource-poor people gain less than they should. So we must make sure from early on that benefits from land improvement are shared equally amongst the community.

①

When land is bare, there are no benefits except a few handfuls of grass for livestock. In fact, the soil will be degrading in the opposite direction. At

Succession on bare land

first it's most important to protect the site.

By allowing natural plants to grow the soil will improve by itself.

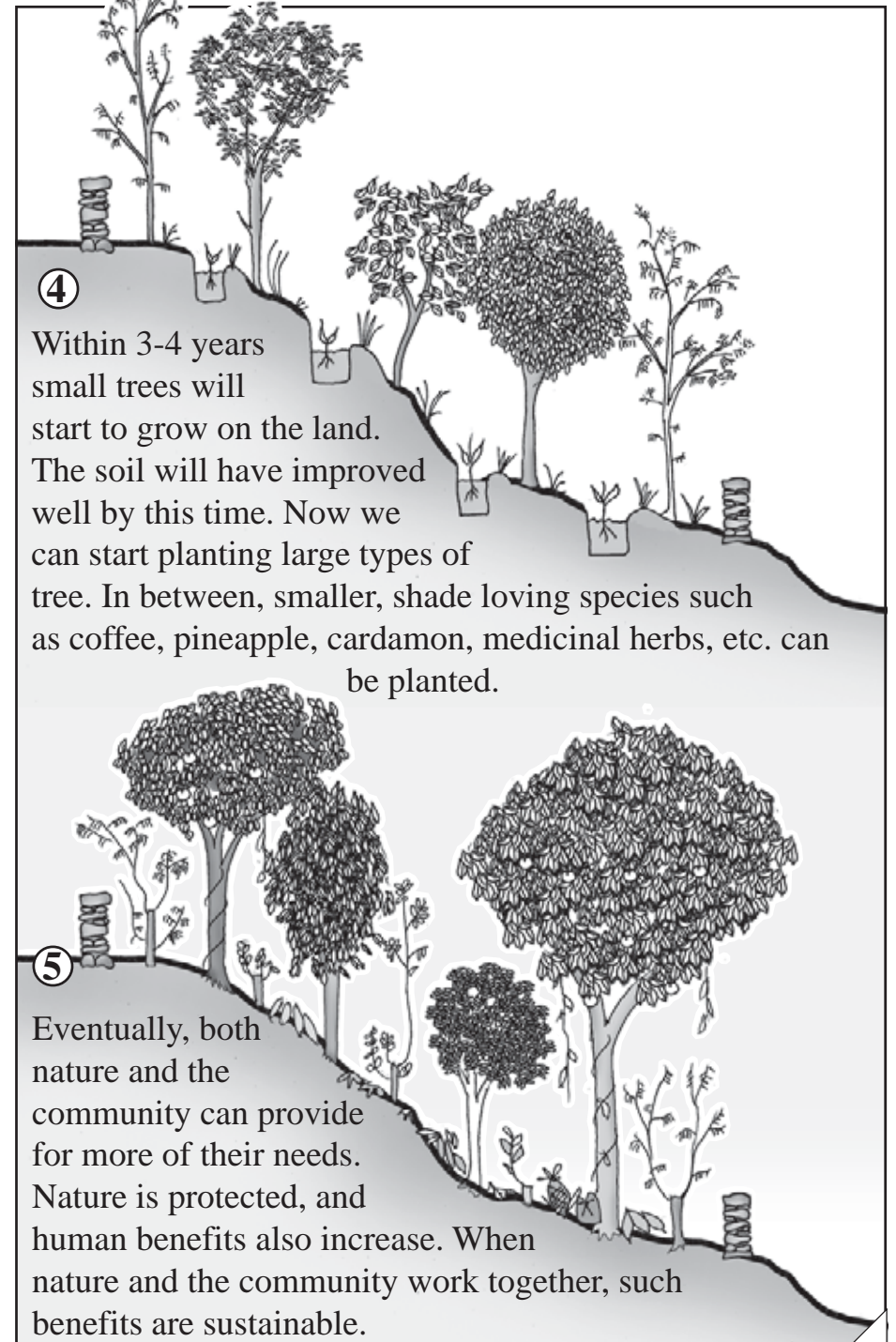
②

When an area is protected from grazing, within 1-2 years grasses and small shrubs will start to grow. These cover the soil, conserve moisture, and start to improve the soil. Livestock must be fed at

home. Grasses which grow on the protected site can be used as fodder for them.

③

After another 1-2 years other seed will be brought to the land by the wind or by birds, and start to grow. As well as providing fodder, these shrubs and trees can also provide small firewood.



④

Within 3-4 years small trees will start to grow on the land. The soil will have improved well by this time. Now we can start planting large types of tree. In between, smaller, shade loving species such as coffee, pineapple, cardamon, medicinal herbs, etc. can be planted.

⑤

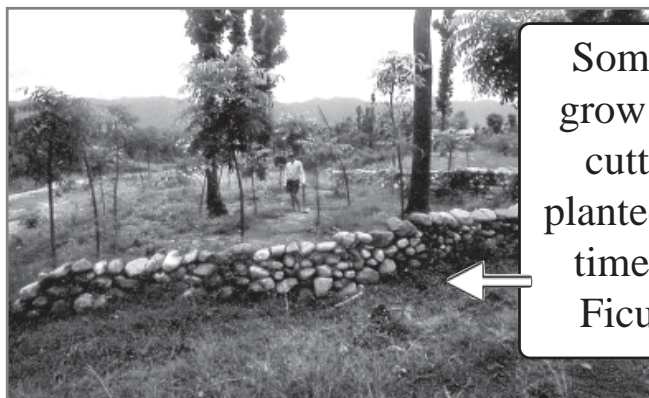
Eventually, both nature and the community can provide for more of their needs. Nature is protected, and human benefits also increase. When nature and the community work together, such benefits are sustainable.

One piece of land improvement

A stone wall protects the land where seedlings have been planted



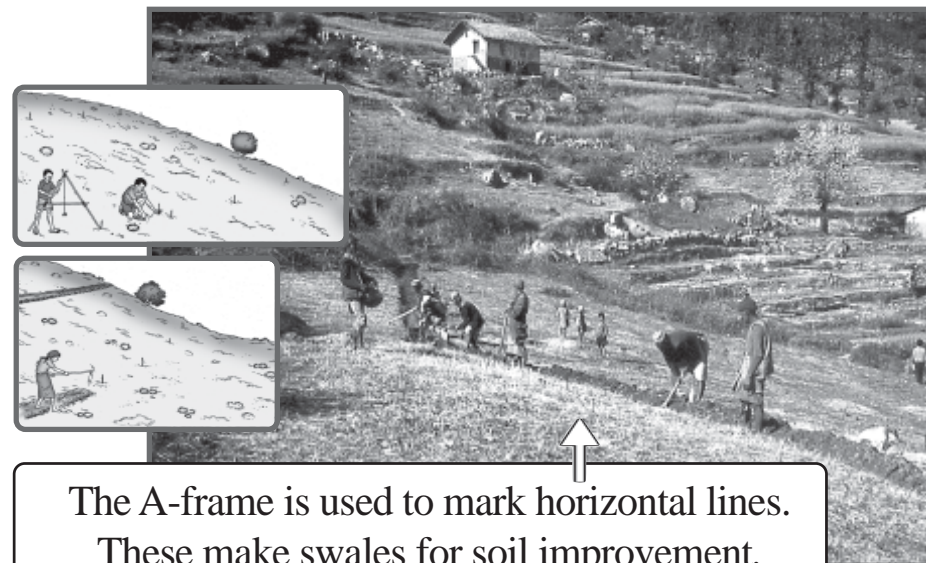
Some trees will grow easily from cuttings when planted at the right time. These are Ficus cuttings.



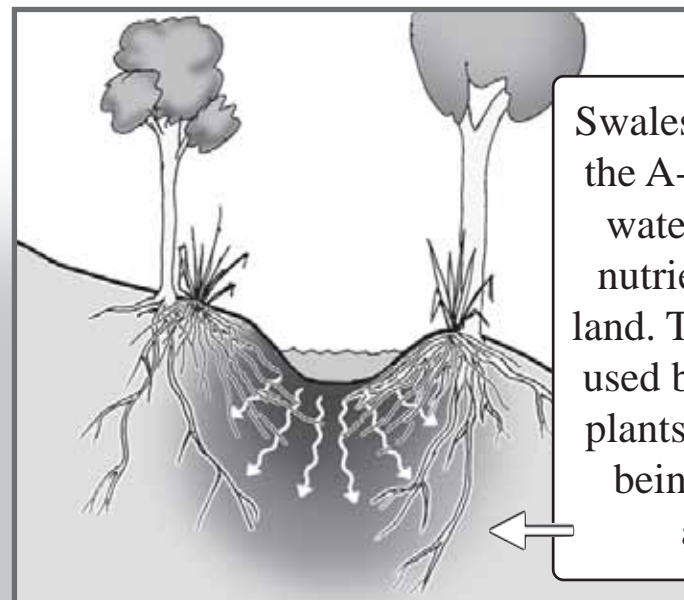
After just 2 years, the area is green and productive



It is important to prevent water from running off a bare slope. This can be done by using an A-frame to mark out contour ditches, or **swales**. This is described in the *A-Frame* chapter. Let's see how the A-frame can be used.

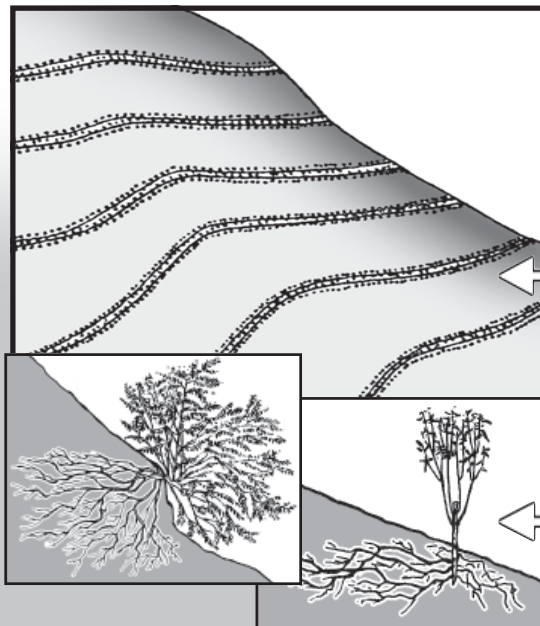
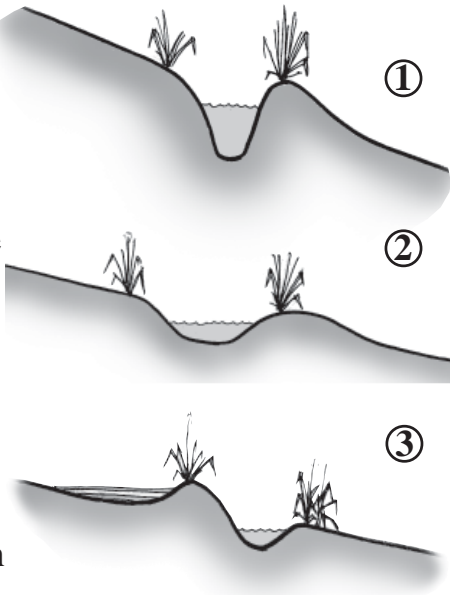


The A-frame is used to mark horizontal lines. These make swales for soil improvement.

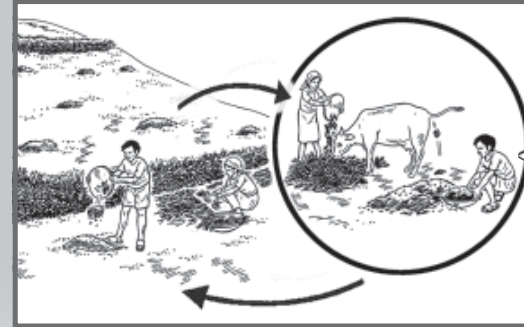


Swales made with the A-frame hold water, soil and nutrients on the land. These can be used by growing plants, instead of being washed away.

The distance between swales depends on the steepness of the slope. The steeper the slope, the closer together the swales should be. In diagram ① the slope is steeper, and the swales are dug deeper and more narrow. In diagram ② the slope is less steep, swales are less deep, and wider. In diagram ③ the soil dug from the swale is put above rather than below the ditch. This can be used to make terraces for cultivation as the soil accumulates above the ditch.

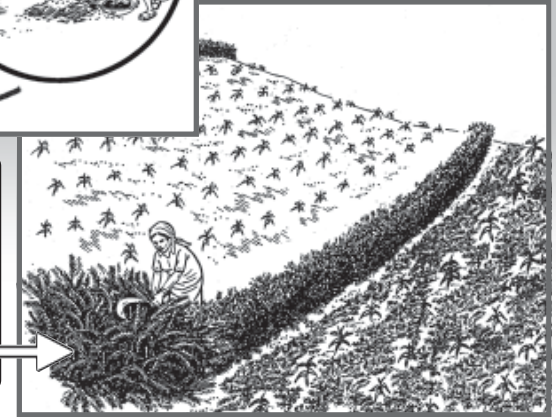


Instead of digging swales, rocks or branches can be laid out on the contour lines marked by the A-frame to prevent soil erosion. Small shrubs can also be planted. Their roots will bind the soil and won't fall over and cause more erosion, as big trees may do.

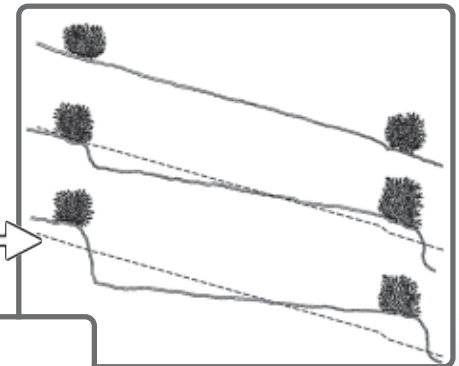


Planting of fodder species will increase compost production....

...or the trees can be cut and leaves put directly on the land (mulching).



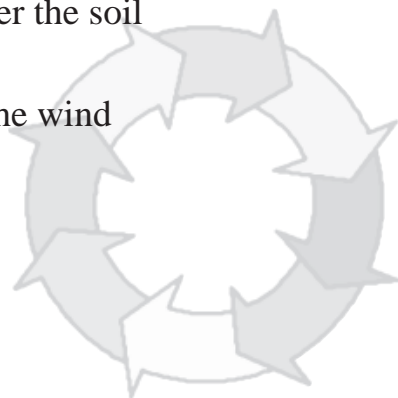
Soil will collect above trees planted like this, and slowly level land will be formed for easier farming.



By stopping soil erosion in this way, hill farmers can make their own land more fertile and productive.

Ways to increase soil fertility

- livestock compost
- compost made of sweepings from the house and yard
- legumes to fix nitrogen
- earthworms
- silt from ponds, streams, etc.
- silt and dust collected from the run-off of the first rains
- deep-rooting trees to cycle fertility
- mulch using leaf litter to cover the soil
- dead insects, birds, etc
- soil and leaves blown in by the wind
- human excrement
- laying turf
- green manures
- rotation cropping
- keeping land fallow
- no-tillage, to allow natural soil fertility



If farmers can use as many of these various local resources as possible to increase fertility, they can help to protect and improve the soil themselves. In this way they can increase production locally and make the homestead strong and productive.



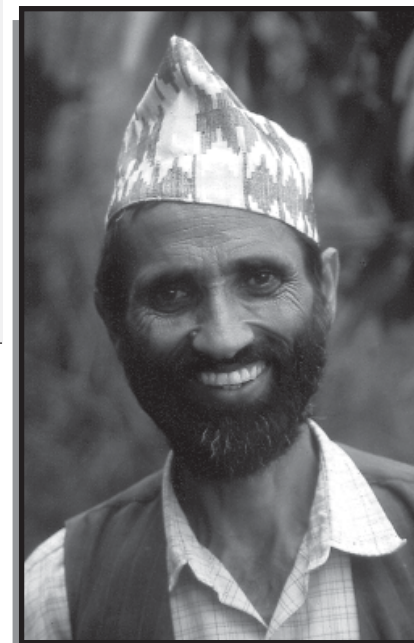
**The soil is our life.
Protect it and be happy !!!**



Farmers' Experience

Mr Surya Prasad Adhikari

From Nepal, Kaski district, Lekhnath - 10, Begnas village, Mr Surya Prasad Adhikari has worked to improve the soil on his own farm. Now let's read about his experiences.



Surya Prasad Adhikari

✍ I started my mixed orchard in 1988. My aim was to work with nature to improve the soil and make it more productive. The area is 1.5 acres, and it was completely bare and degraded, with hardly any grass. First I planted seedlings and mulched all the land with leaves and compost. In the second year I sowed legumes and planted bananas. I cut the bananas and used them for mulch. Then I planted oranges, pineapple, fodder trees, broom grass, and so on. In total there are 55 species I've planted. It's all protected from livestock. The annual production has increased each year, and I even sell seedlings which grow there. There are 800 fruiting coffee seedlings, and I sell oranges and pineapple too. I produce all the fodder and firewood needed at home as well. ✍



Read On !



Subjects Related to Soil Conservation and Improvement



Agroforestry chapter

Plant more trees on farmland to increase production without affecting yields of field crops



A-frame chapter

An easy method of saving soil and water on sloping land



Compost chapter

Make good compost for the soil faster and easier



Mulching chapter

Mulching protects and improves the soil



Green Manures chapter

A method of increasing soil fertility and crop production



Sweepings Pit chapter

Make great compost from domestic waste resources



Living Fence chapter

Make not just a fence, but a productive part of the farm



Forest Management chapter

Good forest management is essential for the soil



Double Digging chapter

Dig twice as deep to get 4 x the vegetable production

