

AGROFORESTRY

What is this Action Sheet about?

It's about agroforestry, a new name for the old practice of growing trees on farmland. Farmers have been practising agro-forestry for thousands of years. By combining trees with crops or animals, agroforestry can help make small farms more productive, adding to family income. Because it helps protect and improve soil at the same time, agroforestry helps people and their environment now and in the future, too!

What are the benefits of agroforestry?

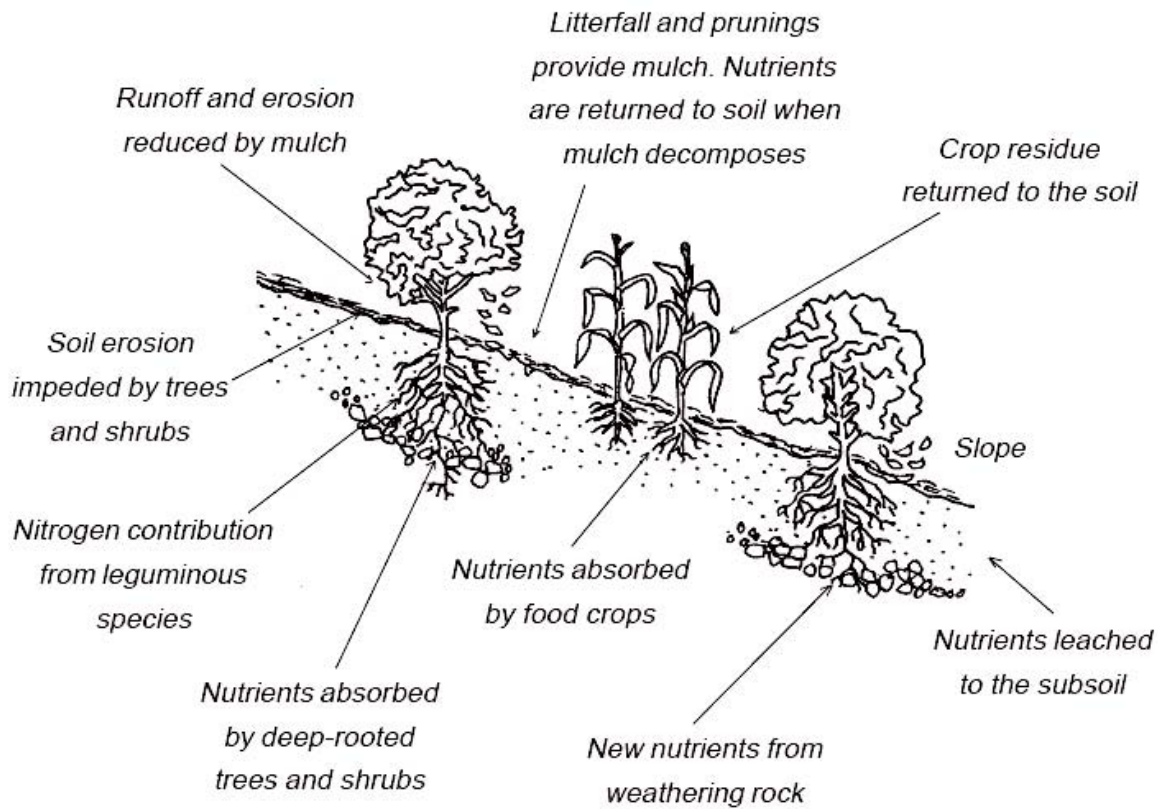
- Agroforestry systems copy nature's variety. Many different crops and trees are grown, rather than only one. This reduces the chance of a complete harvest failure and reduces the number of pests around that spoil the produce.
- Trees have deep roots to access nutrients and water unavailable to crops. When organic waste, in the form of leaves, crop wastes and animal manure, is mixed into the soil, this reduces the need for expensive fertilizers (See Action Sheets: 39: Green Manure/Cover crops for Biomass Transfer, 34: Mulching, 31: Practical Composting).
- Agroforestry makes the best use of light, water and space at different levels. While trees can draw water and nutrients from deep below ground, crops have shallow roots near the surface. Planting climbing plants means that the light above a ground crop is trapped while still leaving space for light to get to the ground.
- Trees can improve soil structure. Deep roots can penetrate compact and hard soil layers. This makes soils more porous, helping soils take in and hold water —and air— more easily.
- Under agroforestry the soil is protected. More than any other conservation measure, keeping the soil covered stops erosion by wind or water.
- Trees also provide shade that keeps the air and soil cooler in hot weather, and warmer in cold weather.
- Trees are able to grow under difficult soil conditions and in places where the climate is harsh, so agroforestry has lots of potential in marginal areas, such as drylands and mountainous regions.
- Trees can also help improve the soil....

How do you know trees improve soils?

You only have to look at the soil under a natural woodland. It is well-structured, and has good water-holding capacity. A store of nutrients is bound up in the organic matter under the trees. Farmers know they will get a good crop on the rich soils of a cleared forest.

Traditionally, farmers have used the practice of "fallow" to allow crop land to rest and be rejuvenated naturally, by the trees and plants that grow up once the crop has been harvested.

The process can take a while - 20 years or more - before the land is able to be farmed once more.



The benefits of nutrient cycling and erosion control in agroforestry

Image: Henry Doubleday Research Association

Aren't many farmers having to reduce fallow periods because of land shortages?

That's true, as populations grow, the pressure on land increases, and often farmers must cultivate land that has had only 4 or 5 years of fallow. Usually this is not enough time for soils to regain their fertility. Crop yields fall, or farmers come to rely on expensive fertilizer.

But when fallow land is enriched with fastgrowing trees or shrubs, an agroforestry practice known as "**improved fallow**", the length of time needed for the soil to recover can be shortened. In effect, this adds organic matter to the soil in the same way that a forest does.

Improved fallow has its origins in traditional shifting agriculture in the tropics. Now the practice is used in many parts of the world to rehabilitate over-exploited, and overgrazed lands or soils otherwise depleted of nutrients and organic matter. If we work with nature, rather than against it, we are much more likely to be successful, and use the land in a sustainable way.



Image: FAO

Surely not every kind of tree helps to improve or maintain soil fertility?

Most trees help soil in one way or another, but some trees are more helpful than others. Leguminous trees are especially valuable because of the plants' association with Rhizobia bacteria. These are microbes that are able to take nitrogen from the air, and turn it into a form that is usable to plants. This is called nitrogen-fixing. Rhizobia bacteria are normally free-living in the soil, but they can infect (inoculate) the root hairs of legume plants, and when this happens, small root structures called nodules grow on the roots to house the bacteria. The bacteria get energy from the plants that feed the bacteria and fuel the nitrogen-fixing process. In return, the legume plant receives nitrogen for growth. (See Action Sheet 36: Planting Nitrogen Fixing Trees)

How does this help the soil and plants?

No plant grows without nitrogen, and many African soils have low supplies of this nutrient. Leguminous plants along with other nitrogen-fixing plants are a major source of nitrogen in soils in many natural environments around the world. Nitrogen from Rhizobia bacteria helps them to grow, and when their leaves fall, or the plants die, more nitrogen becomes available in soil.

In tropical regions, most leguminous plants are trees or shrubs, whereas in temperate regions, nitrogen fixers tend to be herbaceous plants. While nitrogen-fixing plants are important in many natural environments, they have been removed or reduced in most farmlands in temperate regions. Instead, chemical fertilizers are being used to maintain productivity. Planting nitrogen-fixing trees on farms to add nitrogen to the soil lets nature do the work instead.

Where could these trees be planted on a farm so they don't interfere with other crops?

As well as planting on exhausted soil as an **improved fallow/green manure/cover crop**, nitrogen-fixing trees are often planted in or around fields of crops. Planting rows of trees, and growing annual crops between the trees is called **alley-cropping**. Nitrogen fixing trees can be planted in **living fences** and **wind-breaks**. If hedgerows are planted along contour ridges on sloping land (**contour planting**), they can slow down the flow of run-off running down the slope, helping to reduce soil erosion by water. For further information on these agroforestry techniques, see Action Sheets 39 - 42.

How do agroforesters choose which tree species to grow?

When you plant trees, it takes time before the benefits can be reaped. And planting trees adds to a farmer's workload. A farmer has to plan for, plant and care for the trees, especially when they are young (See Action Sheet 49: Tree Planting). That's why it a good idea to plant **multipurpose trees** that can offer many rewards. Planting trees to improve or maintain soil fertility is important. But if you plan carefully, and choose trees wisely, there should be many other benefits to tree-planting.

Choose **multipurpose trees** which not only help improve the soil, but also give you products that you need at home or can sell for cash: food, fruits, nuts, fuelwood, fodder, medicine, fibres, latex or construction materials. For example, if you rely on fuelwood for cooking, growing trees for fuelwood could save you time and effort collecting wood, or money, if you usually have to buy it. Growing more fuelwood may also take pressure off existing woodlands (See Action Sheet 67: Planting trees for fuelwood).

Multipurpose trees can help spread the risks of farming. If plants grown for fodder and soil improvement suffer from a pest infestation which causes damage to the leaves, the farmer can still harvest the wood for fuelwood. With multipurpose trees, it's also easy for agroforesters to respond to changing markets. Suppose a farmer grows trees for fodder and fuel, but there's a big market demand for roundwood for construction. The farmer can choose to trim the trees for poles to sell.

Of course, there is no one multipurpose tree that can provide every single product and service in all growing conditions. Agroforesters need to find out which trees will best match their needs and the needs of the land itself. For example, if you live in the humid tropics, you may be interested in alley-cropping with trees, shrubs and food crops on the same land at the same time in a home garden, whilst pastoralists living in drylands may be interested in growing a **living fence** to keep animals away from a vegetable garden or fodder trees.

Action Sheet 50: Multipurpose trees introduces some of the many amazing trees used by agroforesters in Africa. You will no doubt find more by talking to knowledgeable people in your area. Many useful agroforestry trees are indigenous, but some are exotic.

What's the difference between indigenous and exotic trees?

Indigenous plants are native to the area where they are grown. They are your well-known local trees. Growing them can help attract the local wildlife - birds, insects and mammals - which have always lived alongside such plants (See Action Sheet 33: Natural Pest and Disease Control to find out why this could be a good thing). More research into the best ways to plant and propagate indigenous trees is needed!

Exotic plants have been brought in from another country or continent. Some exotic species of tree, like neem, mango and papaya have been grown in Africa for centuries and are essential to people's livelihoods. However, environmentalists are concerned when large areas of land are planted with exotic species, such as plantations of Australian Eucalyptus, because of the effects on local environment and wildlife.

Another cause for concern is 'invasion' by exotic species. Because they are not eaten by local wildlife, some species that have been introduced from other countries can get out of control and become unwanted weeds. One of the worst example is water hyacinth (See Action Sheet 29).



Leucaena (Image: FAO)

Some exotic tree species need careful management to stop them going wild and weedy. For example, *Leucaena leucocephala* (Ipil ipil), a Central American nitrogen-fixing tree, grown in Africa for soil-improvement and fodder production, has now been reported as a weed in over 20 countries. According to the Global Invasive Species Programme, the problem is that *Leucaena* sets seed and spreads by itself, forming dense thickets. This makes land inaccessible, and sometimes threatens areas of natural indigenous vegetation, full of rare plants that grow nowhere else.

Because the tree resprouts from cuttings, the thickets are very hard to remove. In an attempt to bring this weedy tree under control, the South African government has introduced an American beetle, which feeds on *Leucaena* seed.

The Central American *Prosopis juliflora* (the mesquite tree) has also gone wild in many parts of Africa, growing on land that people would prefer to use for grazing, and competing with plants belonging to the area. Where it is already growing, its firewood, timber, pod flour and gum can be harvested, helping to bring the invasion under control. However, it would be wise to think carefully before planting it where it has not already been introduced. Because *Leucaena* and *Prosopis* are good fodder plants, farmers often have mixed opinions about efforts to limit their spread.



Prosopis (Image: FAO)

Advice to new agro-foresters

THINK OF TREES AS A LONG-TERM INVESTMENT

- Look before you leap. Before you plan a tree-planting project look around, and observe how nature works in your area. See how well different plants grow in different areas, on different terrains, and in different soils. Find out about local trees and what special features they each have, how they grow, and how well they serve other plants, animals and people. Ask advice from other farmers and local experts who have had experience in agroforestry practices.
- Sort out ahead of time whether you are entitled to use all the products at all times from the trees you plant. Rights to trees vary from one society to another. It is important to know who has the right to inherit or own trees; the right to plant trees; the right to use trees; the right to dispose of trees. These rights may be held according to lines of descent, age, gender and religion. If possible, try to get an agreement that covers the use of trees on rented or community land. Make sure that there is a way for this agreement to be guaranteed before investing time and effort in planting trees.
- Start small. Minimize your risks. Tree-planting is a lot of work, especially at the beginning. If you start small, you won't be overworked, and you can do things right. You can experiment without taking too many risks if things fail. If you start small, you can get a good idea of what time and resources you need. Then, when you have learned what does and doesn't work, you can expand on your successes.

Are there any drawbacks to planting trees with crops?

In some areas, some species of trees may increase soil salinity and soil acidity:

- Soil salinity can be increased because of transpiration. This is the process by which plants draw up water from the ground through their roots and pass it out through their leaves into the air as water vapour. Trees generally draw up lots of water this way. In hot, dry places, or in humid, coastal areas, high transpiration and excessive uptake of water from deeper soil layers can draw up salts that are deposited on top of the soil. These are sometimes visible as white crusts.
- Tree growth always increases soil acidity. This is especially true of nitrogen-fixing trees. In fact, soil acidity is the cost of trying to rehabilitate soil quickly using nitrogen-fixing trees. Some trees also produce toxic substances in their roots and leaves that may be released into the soil. All these substances may affect crops or grazing animals.

Another thing to watch out for is competition between trees and crops for water and nutrients. This can be avoided by selecting tree species with deep tap roots, to draw water and nutrients from layers below the root zone of the crop.

- To avoid or manage these problems, talk to other farmers and agroforestry extension workers before making a start with tree species you do not already know well.
- To make soil less acid, you can mix wood ash or finely ground eggshells or seashells right into the soil.

Is agroforestry extra work?

Crops and trees usually have to be planted at the same time, at the beginning of the rainy season, so this is a busy time of year. However, most tree management activities can be carried out during less busy times in the farming calendar. If trees species are chosen well, then labour demand may be spread out. Of course, trees may also be labour-saving devices. For example, tree growth usually provides more shade, leading to less undergrowth. So there may be less need to weed.

Choose **multipurpose trees** to help spread income and workload through the year. Take the example of the jackfruit (*Artocarpus heterophyllus*). Farmers harvest the leaves as fodder during the driest seasons. The same tree produces fruit during another season, providing income and food at a different time of year.

ACKNOWLEDGEMENTS

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FOR MORE INFORMATION

More details about agroforestry techniques can be found in Action Sheets 39-42. For general information on how to plant and look after trees, go to Action Sheet 49, and see Action Sheet 50 - 55 for planting guidelines for specific trees. Growing fruit and nut trees is covered in Action Sheet 38.

CONTACTS

World Agroforestry Centre (ICRAF) – www.worldagroforestry.org
Henry Doubleday Research Association HDRA – www.gardenorganic.org.uk
Food and Trees for Africa – www.trees.org.za
Landcare - www.nda.agric.za
Action Environmental Health Magazine - www.action.co.zw
International Institute of Rural Reconstruction – www.iirr.org

RESOURCES

HDRA International Programme Information Sheets
Agroforestry in the Tropics (PDF 147Kb)
Raising Firewood and Fodder Trees in Nurseries (PDF 190Kb)
Planting out firewood and fodder species (PDF 381Kb)
Agroforestry Technology Information Kit. 1992 (reprint 1998), published by International Institute for Rural Reconstruction (Available from IIRR)