GREEN MANURE/COVER CROPS FOR BIOMASS TRANSFER

What is this Action Sheet about?

This Action Sheet is about growing green manure, often known as cover crops. Green manures are grown so that the biomass (organic matter) in the crop can be transferred back into the soil.

What are green manures?

Green manures, often known as cover crops, are plants which are grown to improve the structure and nutrient content of the soil. They are a cheap alternative to artificial fertilisers and can be used alongside animal manures.

Growing a green manure is not the same as simply growing a legume (nitrogen-fixing) crop, such as beans, in a rotation. Green manures are usually dug into the soil when the plants are still young, before they produce any crop and often before they flower. They are grown for their green leafy material which is high in nutrients and protects the soil.

Mr. Trasizo Phiri adding green manure to the soil Kafunkha Agroforestry Farmers Club, Chiundamila, Zambia (Image: Sarah Watson, PACE)

What are the benefits of using green manures?

Green manuring is a cheap way of improving crop yields for a little extra work. Once you've bought your first handful of seeds, there are no extra costs. You don't have to transport green manure like you do with other fertilizers - they just grow where you need them! Green manures are especially important on farms where there is not enough animal manure available, and when it is not possible to bring in natural fertilizers from elsewhere. Green manures provide a number of benefits to the soil:

Greater soil fertility

Green manures recycle nutrients and add organic matter to the soil. They help prevent nutrients being washed out of the soil. The nutrients are taken up by the green manure and held inside the plant. When the nutrients are needed for the next crop the plants are dug into the soil or used as a mulch on top of the soil. This helps to increase crop yields. Legumes and other nitrogen fixing plants which take nitrogen from the air to the soil are particularly beneficial.

Improved soil structure

Green manures improve soil structure, letting more air into the soil and improving drainage. Green manures help sandy soil hold more water and not drain so quickly.

Prevention of soil erosion

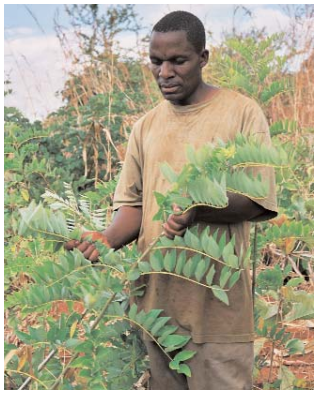
Green manures help to stop the soil being carried away by wind and rain. The roots penetrate the soil and hold it in place.

Weed control

Green manures help to control weeds. Bare soil can quickly become overgrown with weeds which can be difficult to remove. Green manures cover the ground well and stop weeds growing beneath them, by competing with them for nutrients, space and light.

How are green manures used?

Farmers often see the benefits of green manures but many do not use them because they do not know which species to use and how to include them in their own farming system. It is therefore important to plan in advance where and when they are to be grown. There are several ways to use green manures:



Mr Phiri with his crop of Gliricidia sepium, at Kafunkha Agroforestry Farmers Club, Chiundamila, Zambia (Image: Sarah Watson, PACE)

Green manures in agroforestry

Agroforestry is the practice of growing trees and/or shrubs together, with crops and/or animals. The trees act as long term green manures and the leaves can be used for digging in or as a mulch.

The regular pruning of agroforestry trees such as *Gliricidia sepium* and *Calliandra calothyrsus* during the crop growing period provides large amounts of green material for digging into the soil and reduces competition with the main crop. The material can also be used as a mulch. It is spread on the topsoil, usually between crop rows or before a crop has been planted.

As well as improving the soil in the ways described above, trees and shrubs also provide food, fodder, fuelwood, erosion control and other benefits (See Action Sheet 35: Agroforestry).

Long term green manures – Improved fallows

Long term green manures are left growing in the fields for more than one season.

They can be used in the following ways:

- Long term green manures restore poor soil. Using them over a long time has a greater benefit on soil fertility and structure of poor soil
- Long term green manures can be used when new land is being prepared for use, especially to help control difficult perennial weeds
- Long term green manures are used where the land will have a long fallow period. They can be sown at the beginning of the fallow of bush-fallow systems. They help to quickly build up the fertility of the soil and reduce the length of time before the land can be used to grow crops again. See Action Sheet 54: *Gliricidia sepium* for a specific example of improved fallows with a nitrogen fixing tree
- Long term green manures provide green material which can be cut and carried to other fields. Green material can be harvested from perennial species (species that grow for more than one season) for digging in, mulching, composting or feeding to livestock

Crop rotation with green manure

Growing green manures as part of a crop rotation is an important part of

organic farming systems as the green manure helps to build soil fertility. They are particularly useful when grown before crops which need a lot of nutrients.

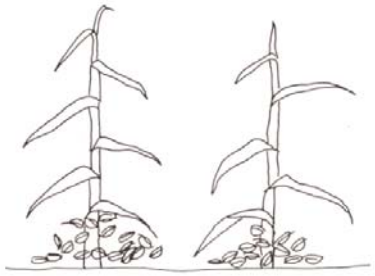
Green manures can be used in rotation:

…whenever there is no crop in the ground, rather than leaving the land bare and allowing weeds to grow and nutrients to leach out of the soil.

…as break crops, when there is only a short time between main crops.

Timing of sowing is important. The green manure must be ready to dig in before the crop next is sown. There should not be a long gap between digging in the green manure and planting the next crop. This is to prevent nutrients from the green manure leaching out of the soil, before being taken up by the next crop.

Undersowing with green manure



A green manure (eg. a bean) sown beneath maize

Undersowing involves growing a green manure at the same time as a crop, among the crop plants. Sometimes they are sown with the crop or slightly later when the crops are already growing. Later planting reduces competition between the green manure and the crop.

Undersowing is sometimes used with maize crops. The green manure is sown under the young maize plants. The green manure seeds are broadcast sown when the second weeding of the maize is carried out. In this way when the maize is harvested the green manure is already established and ready to grow quickly. With this method no extra time is spent preparing the land and sowing the green manure.

Mulching with green manures

Green manure plants can be cut and left on the soil surface as a mulch.

Mulching releases nutrients slowly but helps to prevent weed growth, protects the soil from erosion, and keeps the soil moist by reducing evaporation. See also Action Sheet 34: Mulching.

What do you do with green manure?

Dig it in!

Mr Phiri digging in green manure (Image: Sarah Watson, PACE)

Apart from when undersowing with a green manure, green manure is dug back in to the soil before the crop is grown. Here it decomposes and the nutrients held inside green manure plants are released. The plants take a short time, usually about two weeks, to rot down into the soil before the next crop is sown.

Tips for digging in:

- Green manures should not be ploughed in as this buries the plants and the nutrients too deep. They should be turned in just under the soil surface
- Digging is easier if the plants have been chopped into small pieces before digging. This also helps prevent the problem of regrowth if this should occur
- If digging-in is difficult the plants can be dug in roughly, left for a few days and dug over again

When should a green manure be dug in?

Younger green manure plants are easier to dig into the soil than older ones and land will be ready to use more quickly after they have been dug in. So, over a long period, two short term green manures may be better than one longer term green manure. However this may involve more of time and effort.

For most green manure plants, the best time to dig in is just before flowering begins, but this is different for some species. If plants become too old and tough, they will be more difficult to dig in. Soil organisms will find it difficult to break down and decompose old, tough plants. If this happens green manures can be cut and composted instead.

Which plants make good green manure?

When choosing which green manure plant to use, you should consider the following points:
A green manure must suit the local climate and the soil that it is to be sown in. This will help to keep the green manure healthy and to keep pests and diseases to a minimum

- Choose the green manure to so that the length of time that land is free matches the time the green manure will take to grow
- Green manures should not be closely related to crops to be grown afterwards as they could attract pests and diseases
- The seed should be inexpensive and be easy to get
- The plants shouldn't need extra irrigation, fertilizer or pesticides and should be resistant to local insects and diseases
- You may wish to use a green manure that has other uses, such as being useful as food or fodder
- Fast growing and leafy green manures are often preferred as they provide more nutrients when dug in
- Both leguminous and non-leguminous plants can be grown as green manures. Leguminous or nitrogen-fixing plants have nodules on their roots which contain bacteria. These bacteria take nitrogen from the air, in a process known as 'nitrogen-fixation' (See Action Sheet 36: Planting Nitrogen Fixing Trees). Plants use this nitrogen to grow, but when leguminous plants are dug into the soil, this extra nitrogen is made available to future crops. The ability of legumes to 'fix' nitrogen makes them very good green manures. However they do have limitations and non-legumes can sometimes be more suitable. They may produce more organic matter and have a better root system. They may also survive better and grow faster, and may be able to tolerate extreme weather conditions or poor soils

WATCH OUT FOR UNWANTED INVASION - Some green manures may grow too vigorously and become weedy. This is especially true for plants which are not found locally. They may grow among the following crop or spread into new areas. The green manure should be chosen carefully to avoid this. Growing perennial green manures as annuals will prevent them from taking over and growing in areas where they are not wanted.

Testing new green manure species:

If a green manure is to be used for the first time in an area, it should be tried on a small plot and checked to see that it does not become a weed.

Look out for:

- Light seeds being blown about by the wind
- Green manure plants growing in places where it was not planted
- Long stems that grow from the plant and spread along the surface of
- the soil. New roots then grow at intervals along these stems

These checks should be carried out for at least two years before the green manure is accepted for general use

But we need the land to grow food, not green manure! What should we do?

Green manure helps to keep soils producing food for the long term. However, if food is in very short supply and needed urgently, it may be better to grow a legume from which a bean crop can be harvested and then dig the plant remains into the soil. These plant remains will not break down into the soil so quickly and will not be as good for the soil as younger green manure plants but they will still add some nutrients to the soil for the next crop, and provide a good crop. On the other hand, some green manure crops can grow alongside food crops, on land left fallow or at times of the year when other crops are not growing, helping to replenish the soil for future food production.

What species are people using as green manures in Africa?

There are many types of plants that can be used as green manures. Legumes are particularly beneficial because they increase the amount of nitrogen in the soil. In the tropics they are also more common than non-legumes. Here are some examples of legumes currently being used as green manures by farmers in Africa. More detailed information on these plants can be obtained from the HDRA.

COMMON NAMES	SCIENTIFIC NAME	USE
Butterfly pea, Kordofan pea Blue pea, wing-leafed clitoria	*Clitoria ternatea*	As green manure/cover crop to suppress weeds, add fertility and control erosion
Common bean, Kidney bean French bean	*Phaseolus vulgaris*	Grown as a green manure/cover crop to suppress weeds, add fertility and control erosion. Can be interplanted with other crops
Cowpea, Black-eyed pea	*Vigna unguiculata*	As green manure to suppress weeds, add fertility and control erosion
Lab-lab bean	*Dolichos lablab*	Undersown with maize, the bean plants protect the soil, control weeds, and provide a rich organic fertilizer. Animals can eat lablab bean, and so can people as long as care is taken when cooking. Pods and seeds must be thoroughly boiled several times, with the water changed each time.
Jackbean, Horsebean The most hardy of cover crops, grows in dry climates and poor soils.	*Canavalia ensiformis* Fixes 230 kgs of nitrogen per ha	As intercrop with cacao, coffee and sugarcane or as green manure/cover crop to suppress weeds, add fertility and control erosion. Pods can be eaten like string beans. Beans are not a good fodder for animals, and need to be boiled heavily to be safe to eat.
Velvet bean Farmers call it “the earth’s hat”, because it protects the soil.	*Mucuna pruriens* Fixes 150 kgs of nitrogen per hectare	As green manure/cover crop to suppress weeds, add fertility and control erosion. Undersown with maize and then left as a cover crop after the maize harvest. Climbs fast and so needs to be pruned regularly. Cannot be eaten by humans and needs to be boiled before being fed to animals.
Pigeon pea	*Cajanus cajan*	Used in perennial alley cropping system, foliage cut at 0.8m height for use as green manure or pea, mulch at beginning of growing season or used as cover crop to suppress weeds, add fertility and control erosion
River bean, Sesban	*Sesbania sesban* – Some studies indicate that in 1 year a S. sesban fallow can increase maize yields from 2 to 4 t/ha without application of nitrogen fertilizer	Leaves used as green manure, branches as a mulch. Used in short term rotation fallows to improve soil fertility and suppress weeds. See Action Sheet 55

Where can I find out more?

Local Agroforestry and Agricultural Extension Officers will be able to give advice about buying green manure seeds and about the green manure methods described above. Green Manure is often used in Conservation Agriculture (Action Sheet 30). Action Sheet 56: Where to get seeds might provide useful addresses.

Acknowledgements: This Action Sheet was prepared by Nancy Gladstone, and is based on the Henry Doubleday Research Association's International Programme's Booklet on Green Manure and Cover Crops and the article Green Manure/Cover crops in the Outreach TVE Education Pack: "Soil Improvement in the Tropics"; with further information on tree species from the World Agroforestry Centre Agroforestree Database.

FOR MORE INFORMATION

CONTACTS

HDRA – www.gardenorganic.org.uk
World Agroforestry Centre – www.worldagroforestry.org

BOOKS

'**Tropical Forage Legumes**' (1977) P J Skerman, Food and Agriculture Organisation (FAO) of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy

'**The Cultivated Plants of the Tropics and Subtropics**' (1991) S Rehm and G Espig, The Technical Centre for Agriculture and Rural Cooperation (CTA), 'de Rietkampen', Galvenistraat 9, 6716 AE, Ede, Netherlands

'**Handbook of Legumes of World Economic Importance**' (1981) James A Duke, Plenum Press, 233 Spring Street, New York, USA