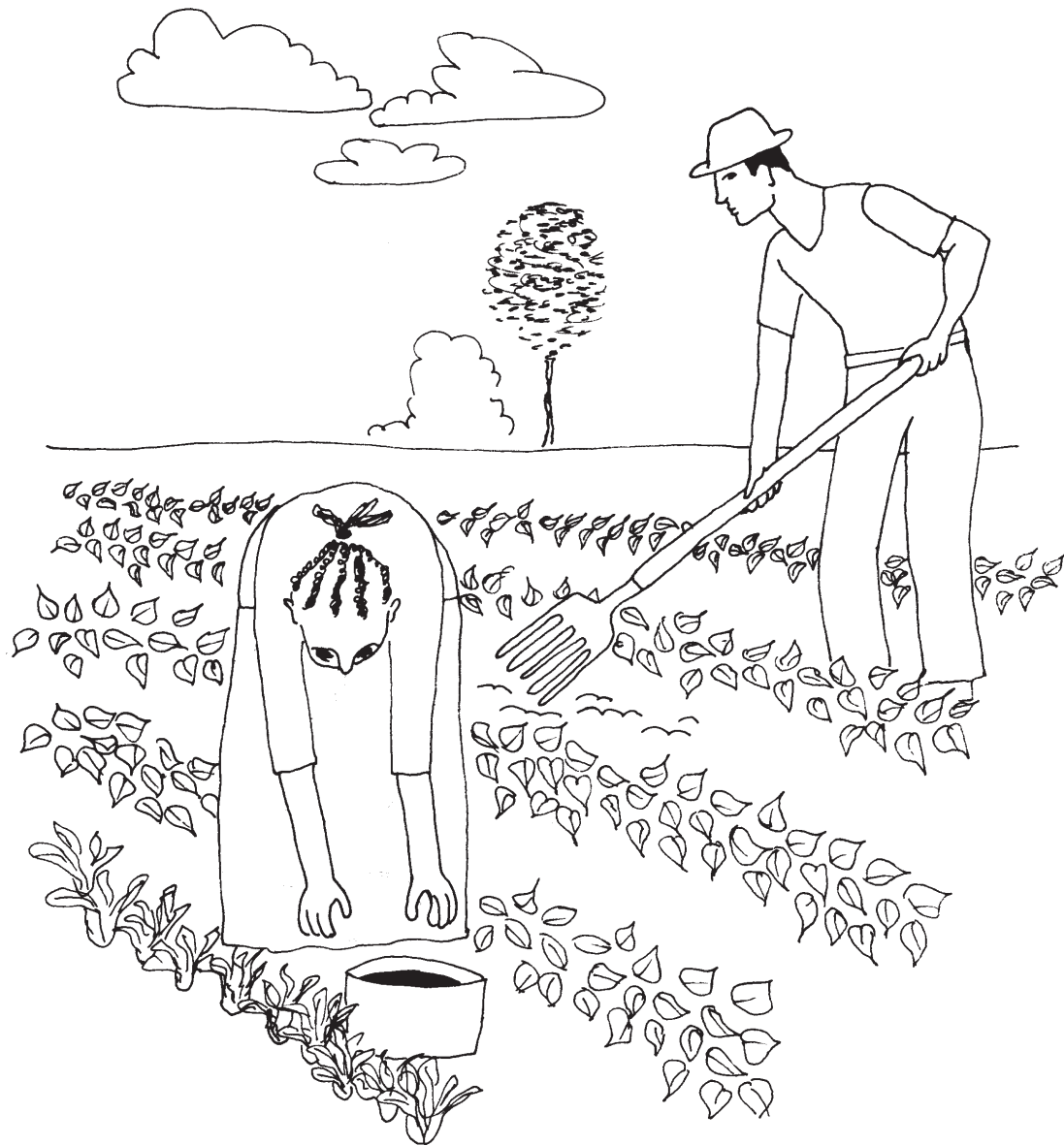


Green Manures / Cover Crops



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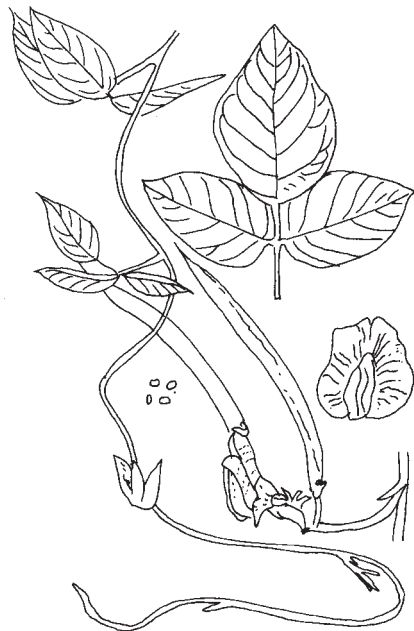
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What are green manures?

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 to complement animal manures.

Growing a green manure is not the same as simply growing a legume 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.

If food is in very short supply 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 plants but they will still add some nutrients to the soil for the next crop.



Centro

(*Centrosema pubescens*)



Stylo

(*Stylosanthes guianensis*)

Two examples of the many plants that can be used as a green manure

Benefits of using green manures

Green manuring offers an inexpensive way of improving crop yields and it takes little extra effort. 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 fertilisers from elsewhere. Although the use of green manures may seem to create extra work, they do provide a number of benefits:

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

How are green manures used?

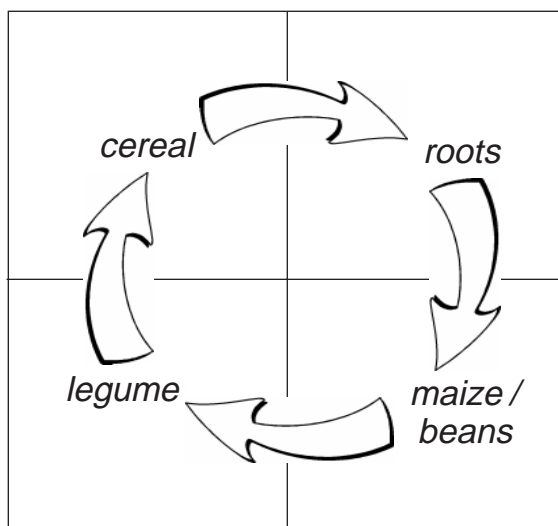
Farmers often see the benefits of green manures but many do not use them because they do not know which species to use and how to include them in their own farming system. It is therefore important to plan in advance where and when they are to be grown.

Green manures in rotation

Growing green manures as part of a crop rotation is an important part of an organic farming system. They help to build soil fertility and 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.



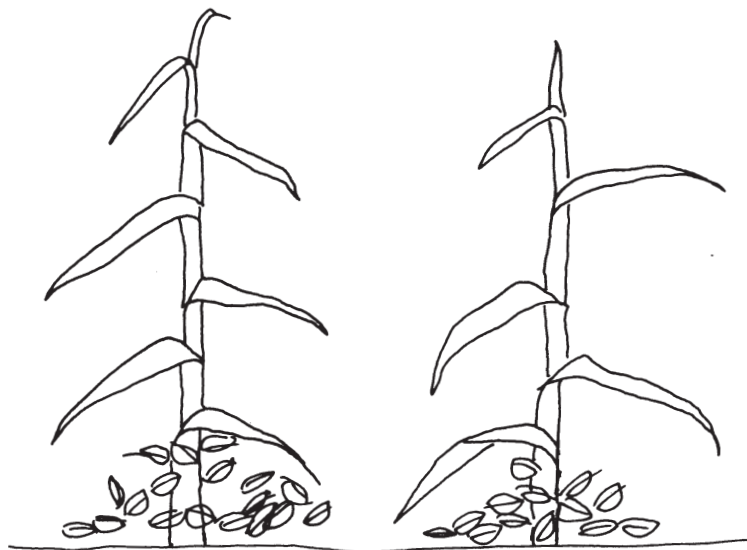
An example of a rotation where a legume is used as a green manure

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.

Green manures and undersowing

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. This reduces competition between the green manure and the crop.

For example, undersowing is sometimes used with maize crops where a 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. This method means that no extra time is spent preparing the land and sowing the green manure.



A green manure (for example a bean) sown beneath maize

Long term green manures

Green manures can be grown for more than one season and 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 land is to 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.
- Long term green manures provide green material which can be cut and carried to other fields. Green material can be harvested from perennial species such as alfalfa (*Medicago sativa*), for digging in, mulching, composting or feeding to livestock.

Green manures for mulching

Green manure plants can be cut and left on the soil surface as a mulch. Mulching releases nutrients slowly but has some advantages:

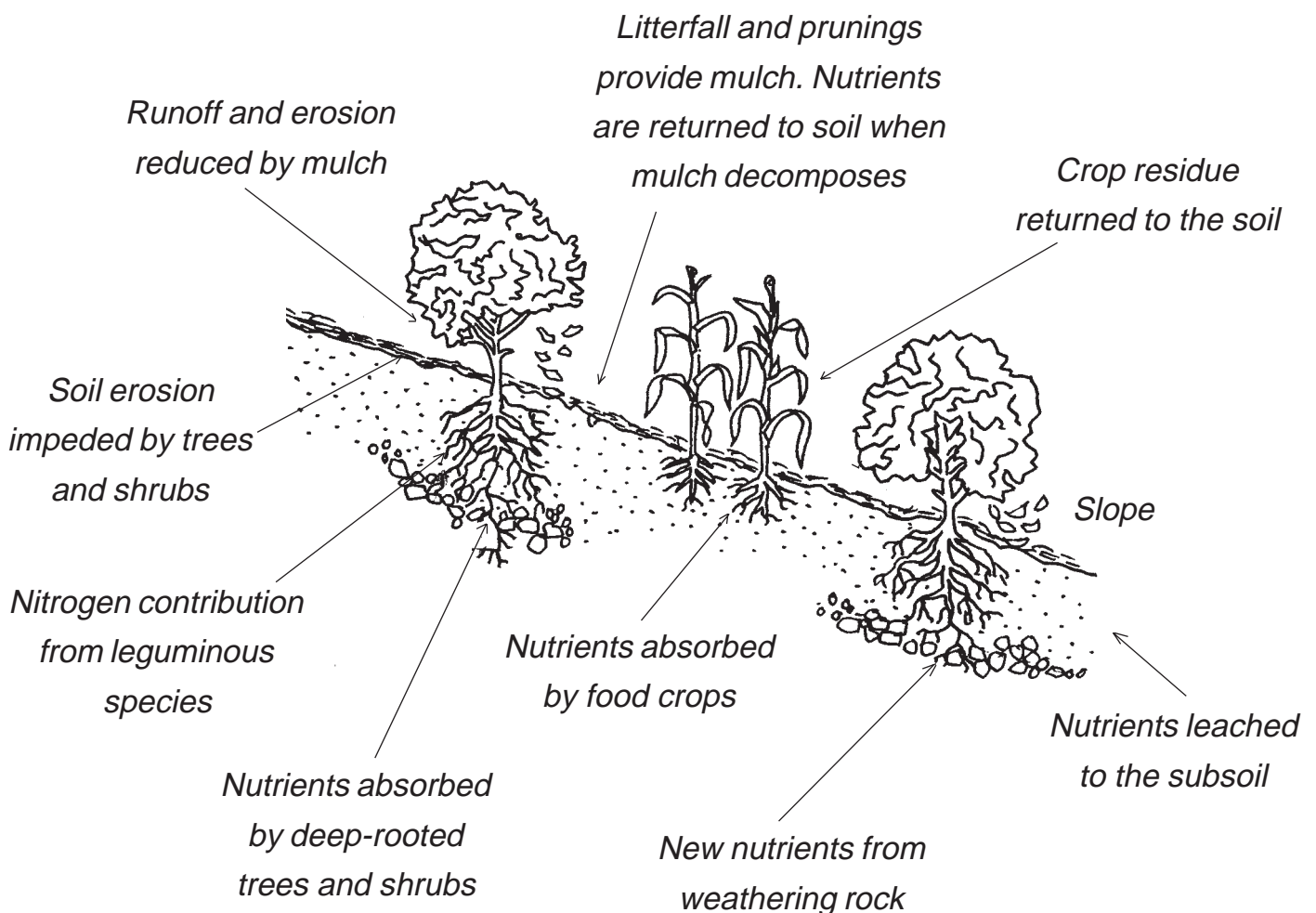
- Mulching helps to prevent weed growth
- Mulching protects the soil from erosion
- Mulching keeps the soil moist by reducing evaporation

Green manures in agroforestry

Agroforestry is the practice of growing trees and/or shrubs together, with crops and/or animals. The trees/shrubs 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 *Leucaena leucocephala*, Mother of cocoa (*Gliricidia sepium*) and Calliandra (*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 top soil, 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.



The benefits of nutrient cycling and erosion control in agroforestry

Digging in green manures

Before a crop is sown the green manure is dug back into the soil. 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.
- 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.



Digging in a green manure

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.

The choice of 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.
- Fast growing and leafy green manures are often preferred as they provide more nutrients when dug in.
- Green manures should not be closely related to the following crop as they could attract pests and diseases which may affect the following crop.
- It is important to know whether seed is easily available and affordable.
- The length of time that land is free and how long the green manure will take to grow.
- Plants which can be grown as a green manure include legumes and non-legumes. Legumes have nodules on their roots which contain bacteria. These bacteria take nitrogen from the air. This is known as 'nitrogen-fixation'. Plants use this to grow, but this extra nitrogen is also made available to future crops when the legumes are dug into the soil. 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.

Legumes will only fix nitrogen if the right type of bacteria, for example *Rhizobium*, are in the soil. This is especially relevant if the legume is not a local plant. A product containing these bacteria can be bought but it may be expensive. Even if the bacteria are provided, other non-legume plants can be better in some situations. 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.

Other important considerations

It is possible that 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. 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. Things to check for are:

- Light seeds being blown about by the wind.
- The green manure plant 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.

Checks should be carried out for at least two years, if possible, before the green manure is accepted for general use.

Growing perennial green manures as annuals will prevent them from taking over and growing in areas where they are not wanted.

Legumes

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 for which detailed information can be obtained from HDRA.

COMMON NAMES	SPECIES	RECOMMENDED APPLICATION
Butterfly pea Blue pea, wing-leaved clitoria	<i>Clitoria ternatea</i>	As green manure/cover crop to suppress weeds, add fertility and control erosion
Centro	<i>Centrosema pubescens</i>	As green manure/cover crop to suppress weeds, add fertility and control erosion
Cluster bean Guar, Siambean	<i>Cyamopsis tetragonoloba</i>	As green manure/cover crop to suppress weeds, add fertility and control erosion in rotation with crops
Common bean Kidney bean, French bean	<i>Phaseolus vulgaris</i>	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	<i>Vigna unguiculata</i> , <i>Unguiculata</i> spp.	As green manure to suppress weeds, add fertility and control erosion
Egyptian clover Berseem clover	<i>Trifolium alexandrinum</i>	As a green manure/cover crop, to suppress weeds, add fertility and control erosion. For intensive or long fallows can be cut to 3 to 5cm height and allowed to regrow
Fava bean bean	<i>Vicia faba</i>	As green manure to add fertility and control Broad erosion, in rotation with main crop
Grasspea Chickling vetch, Khesari	<i>Lathyrus sativus</i>	As green manure/cover crop to suppress weeds, add fertility and control erosion in rotation with crops
Greenleaf desmodium Beggarrlice	<i>Desmodium intortum</i>	As green manure/cover crop to suppress weeds, add fertility and control erosion in rotation with crops
Hairy vetch , Winter vetch	<i>Vicia villosa</i>	As green manure/cover crop to suppress weeds, add fertility and control erosion
Jackbean Horsebean	<i>Canavalia ensiformis</i>	As intercrop with cacao, coffee and sugarcane. As or as green manure/cover crop to suppress weeds, add fertility and control erosion
Lab lab bean Hyacinth bean, Egyptian bean	<i>Lablab purpureus</i>	As green manure/cover crop to suppress weeds, add fertility and control erosion. Good green manure for the dry season

COMMON NAMES	SPECIES	RECOMMENDED APPLICATION
Lima bean Sieva bean, Butter bean	<i>Phaseolus lunatus</i>	As green manure to add fertility and control erosion in rotation with crops
Mung bean Green gram Golden gram	<i>Vigna radiata</i>	Grown as a green manure/cover crop, to suppress weeds, add fertility and control erosion. In rotation with rice or intercropped with rice or other crops
Pigeon pea Dahl, Longo Red gram	<i>Cajanus cajan</i>	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
Rice bean Climbing mountain bean	<i>Vigna umbellata</i>	As green manure/cover crop to suppress weeds, add fertility and control erosion, commonly used in rotation with rice
Soybean	<i>Glycine max</i>	As green manure to add fertility and control Soya erosion, in rotation with main crop. Can be sown with main crop to mature after main crop for bean harvest
Stylo Brazilian stylo, Brazilian lucerne	<i>Stylosanthes guianensis</i>	As green manure/cover crop to suppress weeds, add fertility and control erosion
Sunnhemp Indian hemp, Brown hemp	<i>Crotalaria juncea</i>	Grown as a green manure in rotation with other crops to suppress weeds, add fertility and control erosion
Velvet bean	<i>Mucuna pruriens</i>	As green manure/cover crop to suppress weeds, add fertility and control erosion. Often used to protect the soil through the wet monsoon season
White sweetclover Hubam, White melilot	<i>Melilotus alba</i>	As green manure/cover crop to suppress weeds, add fertility and control erosion. Useful if seeded along with a grain crop to allow time to establish while crop matures, also good for improved fallow
White tephrosia	<i>Tephrosia candida</i>	Used as cover crop in plantations to suppress weeds, add fertility and control erosion. Intercropped and used as contour hedging with tobacco, rubber and cinnamon for mulching
Winged bean Asparagus pea, Goa bean	<i>Psophocarpus tetragonolobus</i>	Grown as a green manure to suppress weeds, add fertility and control erosion

Reference list

'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

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Further information on green manures/cover crops, and on organic farming can be obtained from HDRA. Other publications include booklets covering green manures, weed control and the neem tree, as well as single information sheets about crop pests and diseases and their control, natural pesticides and green manures. Please write to:

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The aims of HDRA - the organic organisation are to carry out scientific research into, collate and disseminate information about, and promote interest in organic gardening, farming and food in the UK and overseas. For more than a decade, HDRA's international programme has been involved in the support and extension of sustainable farming practices; supporting research on aspects of tropical organic agriculture, providing advice and literature on appropriate organic techniques and providing tree seeds and technical information to organisations involved in tree planting and research.

We gratefully acknowledge the generous support of the Charlton Community Development Trust in the production of this booklet.

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